

VANUXEM LECTURES  
1913

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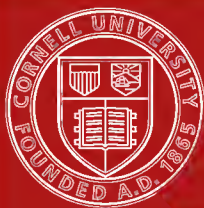
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# LOUIS CLARK VANUXEM FOUNDATION

## LECTURES

DELIVERED IN CONNECTION WITH THE  
DEDICATION OF THE GRADUATE COLLEGE  
OF PRINCETON UNIVERSITY  
IN OCTOBER, 1913

BY

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## NOTE

The four lectures here printed were delivered in the East Room of McCosh Hall on the two days preceding the dedication of the Graduate College of Princeton University on October 22, 1914. The lectures of Professor **Boutroux** and Professor **Riehl** have been translated for this volume.



# **SCIENCE AND CULTURE**



# SCIENCE AND CULTURE

By ÉMILE BOUTROUX

## I

Science and Culture—few words are heard more often in our day and few words cause so many controversies and discussions on all sides.

Does culture—to use the word in its exact sense—arise naturally from the progress of science or has culture her own conditions, her own laws, her progress or her decadence in a domain distinct from the true domain of science?

More than this, might it not be maintained that science in the state she has reached during the ages, far from being favorable to culture in the classic sense of the word, rather tends, by the growing importance she gives to spe-

cialization, to substitute for culture a mechanical training of an entirely different sort?

These questions suggest themselves today to all reflecting minds and it seems particularly opportune to discuss them here, in this college, which has set before itself the ideal of being at the same time a laboratory of pure science and a school of high culture.

We must not be surprised to find ourselves confronted by this problem: it does not date from yesterday. Humanity in the course of its history has already, at many recurring intervals, passed through crises analogous to the situation we have before our eyes.

Long ago among the ancient Greeks, the appearance of the Sophists meant a conflict of this kind. Some bold investigators sketched the foundations for a science of nature to be constructed not as before, say in the cosmogonic doctrines, from the standpoint of man, his beliefs and his desires, but from the standpoint of nature itself. They were called physiologues. They tried to find out whether the substance of things is one or multiple, changing or immutable, formed of visible elements or of

numbers, or of atoms, or of particles infinitely tiny but qualitatively different; whether the action of an entirely mechanical necessity is enough to account for the order and the marvellous diversity of the phenomena of the universe. In magnificent systems, they displayed, as in a vast panorama, the history of the world, its origin, its course, its destiny.

But what became of man in the midst of this universe? His virtues, his thoughts, his arts, his institutions, his life—had they any reality, any value? Socrates, crowning by a positive doctrine the critical work of the Sophists, was not content with protesting against a science which ignored or absorbed man; he put in the foreground human duties and the knowledge and culture of self. Then Plato and Aristotle found a way to make human virtue itself the point of departure for all wisdom, and the crisis precipitated by the Sophists was resolved into a harmony arising from the subordination of the science of nature to ideal culture.

A second crisis arose, at the end of the Middle Ages, when scholasticism seemed to have established to all eternity a science ade-

quate for all things human and divine, a science before which man, as man, could not pretend to take any attitude but one of obedient submission—complete and absolute.

Once more man protested. Every one knows with what eloquence that protest is expressed by Goethe's Faust:

*Was man nicht weiss, das eben brauchte man,  
Und was man weiss, kann man nicht brauchen.*

*Weh! Steck' ich in dem Kerker noch?*

*Flieh! Auf! Hinaus in 's weite land!*

The works of a Rabelais or a Montaigne are nothing else but a continual revindication of the rights of culture and of life, in the presence of the tyranny of abstract science. "Knowledge without conscience," said Rabelais, "is simply the ruin of the soul." And Montaigne: "Science without judgment is the destruction of the mind."

Finally, with Descartes, the principle of culture triumphed, and triumphed, moreover, in such a way as, at the same time, to maintain



and strengthen the rights of science itself. For Descartes insisted that human culture consisted essentially in the culture of the reason, which finds its satisfaction in science, as well as in those moral truths which assure the dignity of man and direct him towards God. The treatise entitled *Regulae ad Directionem Ingenii* opens with this sentence:

*“Studiorum finis esse debet ingenii directio ad solida et vera de iis omnibus quae occurrunt proferenda iudicia.* (The aim of study should be the mind’s culture, enabling us to utter well founded and true judgments about anything that may occur.)

The Scholastic logic has been the art of reasoning; the Cartesian logic was the art of thinking.

Very soon, nevertheless, scientism and intellectualism dominated men’s minds so completely that they threatened to destroy feeling and spontaneity. That was the time which is called the Epoch of the Enlightenment, whose masterpiece is the “Encyclopedie.”

Then another crisis arose with Rousseau for herald. With a fire and an enthusiasm

whose influence the world still feels, he exalted the virtue and the happiness which spring from a naïve confidence in the simple suggestions of the heart and of nature and claimed for these the superiority over the intelligence working apart from the soul and from the sense of life. Not that he ended with the idea of proscribing the sciences and the intelligence. He was not long in recognizing that, once lighted, the torch of science can never go out. And so, although he rejects the idea of science as the master of life he accepts the idea of science as the servant of life: the sciences and the intelligence have a wholesome and necessary part in culture if they are directed by the heart restored to its primitive rectitude.

In this way, at many recurrent intervals during the course of human evolution, the genius of culture has set itself face to face with the genius of science threatening to take possession of the entire man, and has triumphed over the tyrannical pretensions of its rival, without denying to science, kept in its proper place, the right to its legitimate development.

We are now passing through a new crisis. Once more science proclaims: "All reality belongs to me! The entire personality of man belongs to me!" And once more man feels astonished and asks: "Is it then definitely proved that my personality is nothing but a vain show? That I am really a thing like other things and that human culture, like the cultivation of trees or plants, ought to be reduced to the passive application of laws formulated by the theoretical sciences?"

The principle of culture up to the present time has triumphed over the assaults which have been made upon it. Is it to be expected that the result of the present crisis will be the same?

## II

It might seem enough for the resolution of this question to appeal to that law of rhythm and alternation which in a general way governs the manifestations of life. Humanity seems to be walking like a drunken man, now escaping a fall to the left hand by an exaggerated movement to the right, now throwing

himself back, by a movement just as exaggerated, from right to left, and so on ad infinitum. Science—culture, culture—science would thus become like the two extremes of the oscillation of a pendulum and the very pretension of the science of the present day to a universal hegemony would be nothing but the prelude to the compensating triumph of culture.

That way of resolving the problem *a priori*, is too simple. There is nothing to prove that humanity must repeat itself to all eternity, and it may very well be that, at a certain moment of its development, the oscillatory movement may give place to a definite progress in one of the two directions, to the exclusion of the other.

Science, the champions of "Scientism" may say, has, in our day especially, acquired new characteristics and it is not proper to judge of its destiny in the future by the vicissitudes of a past, dead beyond hope of resurrection. Human affairs move not only by alternation but also by evolution proper and all evolution is irreversible.

The physics of Heraclites, of Empedocles, of Anaxagoras could easily bow in reverence before a philosophy of culture, because it was itself, to some extent, an art as well as a science. The object of the researches of Heraclites is, according to his own statement, an invisible harmony more beautiful than the visible one: ἄρμονίη ἀφανὴς φανερῆς χρεΐτων.

The scholasticism of the Middle Ages, based on authority, could not maintain its position before a criticism absolutely resolute to submit without pity all human beliefs to discussion by the reason and to the test of nature.

And however extended the domain of science and of intellectual systematization may have been in the eighteenth century, it was very far from embracing all parts of reality. Science lacked instruments and appropriate methods for extending the reign of its laws beyond physical nature to life and the human soul. That is why feeling, making head once more, was able to stop the progress of its adversary and, in a short while, to display

itself triumphantly and without restraint in the art and literature of Romanticism.

Conditions are not the same today; and there is really place for the question whether the pretensions of science, so often renewed, to govern by her sole power, not only all human knowledge but all human life, are not on the verge of a final triumph. The general evolution of humanity could in that case be formulated thus: from man to things, from feeling to reason, from art to science.

The science of today, the apostles of "Scientism" say, is aware of possessing certitude. The science of today rests on facts and logic and the history of human thought, as well as the analysis of human knowledge, has demonstrated that the observation of facts combined with logic is the only means of reaching that complete agreement between different minds, apart from which there is no such thing as true certitude.

That is not all. Claiming for its domain all objects the knowledge of which can be gained by experience and logic, science has the right not only to claim the possession of

certitude but also to deny that there is certitude anywhere else but in science.

Doubtless, according to the opinion of the average man, there is a certitude based on feeling alone and the energy which characterizes it is no less than that which is inherent to scientific certitude.

But science sees in it nothing but a condition of soul entirely subjective, comparable to dream or desire. The word belief or fancy would be better adapted to describe it. Far from its being the case that truth depends on certitude, we must rather say that certitude depends on truth. Let nobody, then, pretend to know, where science confesses ignorance. Nothing is knowable for man but what can be scientifically known.

Consider also, the scientists urge, that, since Galileo and Descartes, the whole domain of being has come little by little under the control of science. Doubtless science is not satisfied unless she measures and calculates and many facts taken by themselves cannot be measured; for instance, all vital phenomena; and psychological phenomena are even more

intractable. But science has in that respect invented the method of indirect measure or equivalent. For phenomena immeasurable in themselves she substitutes phenomena directly measurable, connected with the first by an exact law. Thus, for example, heat is measured, not in itself, but by the height of a column of mercury. Thanks to the generalization of this method, there is no phenomenon which cannot theoretically be submitted to scientific investigation, and Berthelot was able to say from the standpoint of rights if not of facts: "Nature has for us no more mysteries."

We are then told not only that there is no certitude outside of science, but that the jurisdiction of science includes everything. How then can there be a culture outside of science?

You may allege the irreducibility of feeling, the opposition we perceive each day between the intelligence and the heart, science and life. But the celebrated English philosopher, Leslie Stephen, has given for this fact an explanation which very much diminishes its importance. "The imagination," he says, "lags behind the reason." Imagination, feel-



ing, will, do not follow the reason except at a distance and, in a way, in spite of themselves. Yet little by little they must yield to the action of reason, for this latter is intangible and irresistibly increases steadily in power, while feeling, in spite of its repugnance, can always be weakened and naturally grows weaker with time. Drops of water falling without ceasing finally wear away the solid rock.

This solution of the conflict is certainly the one a man of intelligence ought to hope for and the one he ought to work to bring about.

Besides, adds the scientist, science as she learns more perfectly her own nature and power becomes more sufficient for education and culture.

In the first place, she teaches better than anyone the worship of truth, and what is more noble, more sure, more just than to consecrate oneself to that sublime religion? To seek for truth—that is not only to realize in oneself, in all its purity, intellectual virtue; it is—by the subordination of material interests to an ideal interest, by the friendship which the

seeker naturally forms with those who pursue the solution of the same problems, by the joy which one feels in possessing a blessing as real as it is sublime—to develop in oneself, in the most certain way, *moral* virtue.

By general consent, scientific study and research are not only the acquisition of knowledge—an external enriching of the mind; they are literally a culture. They may indeed be called the necessary and sufficient culture. There is, indeed, no essential faculty of the human soul which science does not develop and direct in the best way. And, so far as those sides of our nature are concerned which require for their development the rejection of scientific influence, they should be considered—not as permanent characteristics of man, but as survivals of a past condition which it is highly desirable to obliterate.

Such seems to be today, in the words of some of her representatives, the ambition of science. If that pretension is well founded, the ancient conflict of science and culture is at last ended. Science has definitely conquered and no counter triumph of culture as

irreducible to science, is henceforth possible. Science is herself theory and practice—truth and action—the abstract and the concrete—knowledge and life.

### III

Before asking ourselves if that conception is true or false, it might perhaps be interesting to try to form a picture of what human life would become if it were actually governed in all its parts by science and only by science. It is one thing indeed to sing hosannas in honor of science; it is another thing to see clearly all the consequences which the exclusive sovereignty of science would bring to pass. If it appears that these consequences would be enormous and paradoxical, it by no means follows that the principle is false, because the mission of truth is not to be agreeable to us, yet such an outcome of the principle will be an additional reason for not accepting it without a close examination.

Auguste Comte loved to repeat that to surrender human life to the men of learning and

nothing else, would be to break all the moral and social bonds which exist at the present moment among men and to divide humanity into groups of specialists, strangers or even enemies to one another. Science knows no other social relations except those which result from the division of labor. An entirely external coordination would, then, replace that community of feeling, thought and existence which characterizes our existing society, born of the family and dominated by the idea and the feeling of humanity. And, warming to the discussion, the founder of positivism plunged with growing passion into invective against the professional vanity, the onesided spirit, the absence of mutual understanding, the lack of practical sense which he attributed to men of learning who are nothing else. He particularly disliked mathematicians or mathematically-minded men, and held them responsible for all the evils which afflict society—especially for the French revolution, that abomination of desolation.

Auguste Comte was a little reckless in his use of anathemas, and the men of learning

punished him by insinuating that his brain probably never quite recovered from the derangement which twice attacked it.

Without sharing the fury of Auguste Comte, one can notice that scientific work presupposes more and more an extreme specialization, and that, in conformity with this requirement, the system of faculties distinct and autonomous enjoys, in our universities, a growing favor. In perfect calmness we can observe that, in our society greedy for progress and above all for scientific progress, the certificates for elementary studies are, more and more, the only ones which still keep a general character. Have we not therefore the right to suppose that, if men were guided by science alone, they would be comparable, looking at society as a whole, to workmen in factories, each one shut up to the special task which has been assigned to him.

But, you will say, does not man remain with his social sense, with his love for the traditions of his country and his race, with his ideal aspirations which the rôle of a wheel in a machine can never satisfy? Are not these real

data which a science resolutely experimental could not fail to recognize and respect?

These realities, it is to be noticed, gain their moral and social meaning from the subjective elements which they include. But the function of science is to eliminate the subjective and to resolve it into the objective. She would not, therefore, know how to attribute the slightest value to our aesthetic, moral or religious ideas as we are conscious of them. If, at the present moment, science does not see the way to resolve them completely into objective elements, she thinks such a resolution possible, and the attachment of man to those idols which he has created himself can not be, for her eyes, anything but superstition, routine, error. To sum up—the task which science sets before herself, the task which she thinks it both a right and a duty to consider realizable, is to dissolve and to reduce to an infinite number of units of energy entirely physical everything which constitutes the essence of man. Her manner of explaining man means suppressing him. When man ate the fruit of the tree of science, he signed,

in a very real sense his own death warrant. If, some day, science realizes her ambitions, man, deprived of everything which gives him a reason for living, will either disappear or will be so changed as to resemble in nothing what we call man. This is doubtless an ideal limit which practically does not seem possible of attainment. But, if science ought to be our only guide, this is the goal we march towards, and we ought to measure human progress by the extent to which humanity is dehumanized.

Whatever may be the feelings which the prospect of such a destiny arouses in us, we have nothing to do, if we are reasonable, except to accept it gracefully. For, even though we rebel, we shall be none the less forced to bow to it, and then we shall be at the same time conquered and culprits.

. . . . . ἦν δὲ μὴ θέλω,  
κακὸς γεγόμενος, οὐδὲν ἥττον εἶσομαι,

one could say, using the words of the Stoic Cleanthes: What dignity would man preserve if he put his pride above the truth?

But is this the truth? Is science really des-

tined to absorb the whole man and to reduce him to the dust of atoms?

That hypothesis arises from a misunderstanding which Descartes denounced long ago. It supposes a confusion between science already formed or made and science which is in the making, or rather, a confusion between science considered as a thing in itself and science as it actually exists. If science were a thing in itself, ready made from all eternity—if man had nothing to do but to discover it as a treasure buried in the ground is discovered, then it would be true that man does not really exist except in a scientific form—that is to say, so far as he is a man, he does not exist at all. But that so-called science in itself, is nothing but a creation of reason, imagined by metaphysicians of the absolute or by university professors inclined by profession to dogmatism. The only science which exists is the science which is being formed, the science which is becoming science—and that is not really a discovery—it is rather an invention. If there is one result which is plain from the deep study which, in our day espe-



cially, has been made of the origin of science, it is this: the essential and continuous part which the original activity of the mind has played and plays, both in the formation and elaboration of scientific concepts and in establishing the relations of phenomena to those concepts. I would be glad to apply to all science the theory which I have seen my master M. Michel Bréal sustain in regard to language. Against those who assume to explain the phenomena of language by purely mechanical laws immanent in language itself, to wit: by simple invariable connections of elementary linguistic phenomena, Michel Bréal sustains the proposition that the mind, for its own ends and by its own activity, with its capacity for trying, for groping its way, for choice, for adaptation, for aesthetic arrangement, for improving, is the true creator and modifier of language. *Mens agit at molem*: Mind moves the whole. Doubtless it would be possible, to some extent, to reduce any given language to a fixed mechanical system, so that its constitution could be more easily taught to students whose memory was better

than their judgment. But the method of teaching is not the way of creation. The real development of language is not intelligible without making an appeal to the living mind as an essential factor.

Νοῦς ἄν εἴη τῶν ἀρχῶν :<sup>1</sup> Intelligence should be considered a principle, says Aristotle. And the proud declaration of Descartes stands more unassailable than ever: *Scientiæ omnes nihil aliud sunt quam humana sapientia [sive bona mens], quæ semper una et eadem manet, quantumvis differentibus subjectis applicata.*<sup>2</sup> All the different sciences are but human wisdom [or good sense], which always remains the same, though it may be applied to most different subjects.

The truth is that science herself, this language par excellence, refers us to that living spirit—to that subjective principle—which she thought to dissolve into its elements and to eliminate without pity. Not only is it true that she was born from thought, but it is also true that she can never preserve her value and

<sup>1</sup> Aristotle, *Anal. post.*, s. f.

<sup>2</sup> Descartes, *Reg. ad direct. ing.*, init.

her power of improvement except by remaining substantially united to that spirit and activity. "Separate words from the mind which expresses itself in them," said Plato, "and then ask them what they mean: they will keep solemnly silent," *σεμνῶς πάνυ σιγᾶ*. Science can no more do without spirit than the colors produced by the reflection of light can exist without the sun.

But if science, far from absorbing spirit and reducing it to the mechanism she constructs, depends as a matter of fact eternally on spirit, as the leaves and the flowers depend on the tree, it is of the greatest interest to science that spirit should receive the culture which is appropriate, the culture which best assures the health, the vigor, the fecundity of spirit.

That culture, however, of which science is at once the aim and the measure—is it sufficient for our needs?

The scientific faculty is not the only one which is essential for us. We find also in ourselves other ruling faculties: the practical, the artistic, the religious faculty.

If our spirit is really in itself a being, a

principle, a power irreducible and original, why would we not develop all parts of its essential being? Science which presupposes spirit and lives in its life, is herself interested in a culture which will make the spirit as rich and harmonious as possible.

Today, then, as in the epoch of the Renaissance, or in the age of the Sophists and Socrates, it remains true that man ought not to lose himself in science, even the largest and the best established science, but that he ought to recognize that he has the right and the duty to cultivate in himself humanity as such, to be truly a man in the sense at once the largest and the most specific of the word. We can still say with Menander:

‘Ὡς χαρίεν ἐστὶ ἄνθρωπος, ὅταν ἄνθρωπος ᾖ,  
 What an admirable thing is man when he is  
 truly man!

#### IV

How shall we conceive and practice today that culture of man as man, which, in spite of all the changes in society, and even in spite of the unheard-of progress of science, remains

the condition of all progress and the supreme goal to which all our efforts ought to be directed?

Nothing is truer than the affirmation repeated incessantly among us, about the educative value of the sciences, provided the nature and the service of science are correctly understood. True science is not a system of compartments, built once for all, where all the objects found in nature must come by consent or by force to be arranged in order. Science is the very mind of man, exerting itself to understand things and, to succeed in that, as far as possible moulding itself, accommodating itself, enlarging itself, diversifying itself in order to pass in its vision beneath the superficial and uniform aspect of beings and to penetrate to some extent their infinite and subtle individuality.

That is why the science which is truly educative is not the science which assumes to be complete, finished and infallible in its logical simplicity. It is the science which works, which seeks, feels its way, criticises itself, corrects itself, considers itself always provisional

and behaves itself as provisional. The science useful in education is not a science fixed in rigid definitions with a view to teaching and examinations, it is the living science, grasped in the very act of making itself in the laboratories.

The first sort of science is easily accepted by professors and students whose laziness it flatters; it favors dogmatism, routine, apriorism, the assumption of ability to judge all things according to exact and absolute rules. The man who has allowed himself to be moulded in this way by his scientific studies, beholds with impatience the complexity and the obscurities of real things, the secret spring of life and activity which makes them rebellious against arrangement in a logical system. He likes to treat qualities like quantities, realities like abstractions, and to believe that a problem is resolved the moment; eliminating every thing that cannot be reduced to exact and clear concepts, he has deduced from certain principles, plausible in themselves, consequences logically correct.

Living science on the other hand—the

science which follows reality instead of trying to make reality conform to itself—steadily teaches the mind to break away from that tyranny of habit which is nothing but the surrender of the native liberty of spirit to the law of inertia which is the particular quality of matter. In the effort to proportion means to ends, to recognize the complexity and the particular nature of objects in themselves, she appeals to the spirit of sagacity as well as to the spirit of geometry. She not only develops the power of external observation and logical deduction but she sharpens that sort of judgment which discerns the agreement of methods and problems, the meaning and value of results.

Of course we must reject the contention of certain romanticists, that science ought to be controlled by literature, unless we are prepared to accept the cult of matter, figures and force. But, we must recognize, on the other hand, that, if the sciences are to take in the education of mind their due place, they must be taught, not by the dogmatic method of a professor who is nothing but a professor, but,

as far as possible, by the heuristic method, namely the method which a man of learning uses in his researches.

On the other hand, since the object of culture is the development of man as man, it is evident that the study of letters has as much right to be a part of it as the study of science. For, if the sciences show us the effort of the human mind to take possession of things, letters show us the very life of man, made visible to himself in his consciousness and expressed in the language best fitted not only to analyze that life acutely, but to exalt it, to beautify it, to ennoble it by the charm or the grandeur of the very expression of it.

If letters are to fulfill their educational function, we must not look on them as a mere branch of scientific knowledge. It is true that erudition, which is next door to the natural sciences, plays a necessary part in literary studies. But erudition bears the same relation to literature which technique bears to art. It puts us in possession of the elements and the instruments: it takes no account of the internal operation which from these minted



and banal data creates a living and personal work of art. When we find in the authors Pascal has read, in Montaigne for example, more and more of the ideas and even the expressions which form the material of the immortal "Pensées," we only demonstrate with still greater clearness the incommensurability between materials and form; because, after all, the work of Pascal differs radically from the work of Montaigne. Pascal himself said: "The thoughts of an author transplanted in the mind of another writer make, sometimes, a quite new and different growth." *Les mêmes pensées poussent quelquefois tout autrement dans un autre que dans leur auteur.*

In spite of the marvellous progress which erudition and the objective study of literary phenomena are making from day to day, letters remain essentially different from the sciences, and that is just the reason why letters have a part in education which is peculiarly their own.

In a sense diametrically opposed to the superstition of erudition, it is not uncommon nowadays, to hear a defence of the proposition

that, in order to take their proper place in life, letters and art must become entirely conscious of their essential nature, and that this principle peculiar to them, is seen to be, when looked at in its purity, feeling entirely separated from intelligence. This doctrine is what we may call Aestheticism. It affirms the independence and the sovereignty of art, the supremacy of life and intuition, the supernatural and almost divine nature of genius as an infinite and arbitrary power of creation.

Such a doctrine is very opportune and has a useful place in epochs when humanity is tempted to believe that the creative power of the mind is an illusion, when learned men try to persuade us that what we call new, original, a work of genius, appears to be such only because we do not know all its antecedents. By exalting beyond measure the aesthetic faculty, this doctrine may awaken and excite it. In order to develop the forces we possess it is sometimes useful to think we have forces we do not possess.

It is, however, worth noticing that the idea of an art which rests on intuition alone, on

feeling separate from intelligence, scarcely ever appears except at the beginning or end of a great period in the history of art. At the beginning, because science is not capable of keeping pace with inspiration; in the age of decadence, because, tired of beauty which has become classic, certain refined spirits set themselves to look for strange sensations. Art, in the time of full flower, is intellectual and practical, as well as properly aesthetic. In the ages of its highest development, art tends to express, in an idealizing manner, human life in its totality. The Parthenon is not something luxurious, built only to satisfy *dilettanti*. It expresses national beliefs, it possesses the harmony, at once exact and delicate, of a Greek tragedy. And the beauty which streams from it, is the beauty of light, which not only charms the eye but illuminates the world and maintains life.

The truth is that the starting point of the theory which sees in art a quite independent activity of humanity is contrary to reality. There is not in our consciousness any feeling entirely isolated from thought, any intuition

empty of all concept, any creation independent of ideas. If man should try to feel and produce outside of all ideas and all rules, he would become by his own consent, the slave of chance and mechanical necessity, and would produce nothing but bizarre and insignificant works. The activity of genius is not pure creation; it is the production of beautiful things—of things stamped with the seal of perfection and eternity.

An intuition without a concept is for man an impossibility or a simple datum without determinable value.

The problem, then, is not to find out how we can set feeling free from all connection with the intellect, but to form an idea of the way in which our intuitions and our intellectual concepts can mingle with each other in such a manner that, without losing spontaneity and freedom, the creations of our imaginations may be regular, harmonious and in conformity with the laws of intelligence. The study of letters, consequently, ought not to have for its object the development of the imagination considered by itself as an arbi-

trary and capricious capacity for creating. Its object is, rather, the cultivation of taste, or judgment, of what in its highest form is genius—that is to say, that marvellous faculty whose characteristic it is to see, as if intuitively, and to produce, as if spontaneously, things which subsequent analysis proves are perfectly in accord with reason and truth. Literary studies, if they are properly carried on, do not in the least neglect the scientific side of knowledge. But they incorporate science with the imagination and the judgment to the extent of transforming it, as it were, into sentiment and intuition.

From the considerations we have laid before you, we conclude that human culture, when properly carried on, ought to be at the same time scientific and literary—in a word, universal.

In reality, all things in nature cling to each other. A thing isolated from other things, is, because of that very fact, imperfectly and inexactly understood. In order to see justly, we must see everything in its relation to the whole, and, to succeed in raising human nature

towards its ideal form, we must exercise and develop harmoniously all the faculties of man.

But, if that is the case, is not the task which a true culture implies really chimerical, and is it not more practical, instead of aiming to reach something sublime but inaccessible, to restrict ourselves to specialization and the division of labor which is the method approved by human industry and by nature herself.

Certainly the task is just now more difficult than it ever was. But it has not lost its glory and it is worth while not to give up the ideal without having done all in our power to come nearer to its realization.

The universality whose reconciliation with specialization concerns us, can be understood in several ways.

It can be defined as the possession of all the knowledge and of all the talents which human nature is capable of possessing.

Now it is only too clear that, in this sense, universality is an Utopia, not to say an absurdity. A very small number of men, in the past, are reputed to have united in themselves all knowledge then possessed by the na-

tion to which they belonged. Such a pretension, today, would be madness: if we were to divide among so many different objects the small amount of intellectual force we possess, we should condemn ourselves to have nothing but vague and useless ideas in regard to every one of them.

Universality can, in the second place, be understood in a perfectly logical sense as the possession of the general ideas which are the underlying principles of the different sciences and the different arts.

But such ideas, taken by themselves—that is to say, separated from the consideration of the details of things—are scarcely more than empty rubrics, useful at best only to furnish subjects for commonplace conversations or for abstract and sterile disputations.

There is a third way of understanding universality, and that is to look for it, not in the objects of knowledge, or, even, in the concepts which interpret their common characteristics, but in the spirit of man as a living nature, the virtualities of which surpass both the concepts of the intelligence, and the objects

of science. In a general way what we call life, soul, spirit, is the conciliation and reunion by a sort of fusion and internal transfiguration of qualities which, in the world of space and matter, are invincibly exterior and impenetrable to each other. How can, for example, identity and change get united? An insoluble problem in the material or logical world. But life conciliates these two terms. The living being remains himself, while he is evolving. How, in the world of matter, can anything be at the same time young and old, live in the present, the past and the future, inhabit simultaneously different regions of space? The mode of existence which we call consciousness solves those paradoxical problems.

Cannot the spirit of man solve in its own way the problem of general culture?

When a man practices a science for a long time and intelligently, he acquires not only a certain amount of knowledge but, in addition, a certain intellectual disposition which cannot be expressed in any formula, but which is, none the less, real and usable. Thanks to that intellectual disposition, the man of learn-



ing makes an easy and assured progress in the science he has studied. He has assimilated the spirit of that sort of knowledge in such a way that, henceforth, he finds himself at home there.

Now it is a characteristic of human nature, that when several individuals have intercourse with each other, they not only exchange from without certain definite pieces of information or methods of action, but, by a sort of internal contagion from soul to soul and mind to mind exert a reciprocal influence. "It is the peculiar characteristic of mind," says Goethe, "to arouse perpetually the activity of mind." *Dies ist die Eigenschaft des Geistes, dass er den Geist ewig anregt.*

And that influence of one spirit upon another, is much more certain and effectual, when there is not only an exchange of intellectual ideas, but a union of hearts. Who knows, indeed, whether that may not be an indispensable condition? "It is impossible," said Xenophon, "to learn anything from a master one does not love": μηδενὶ μηδεμίαν εἶναι πάδευσιν παρὰ τοῦ μὴ ἀρέσκοντος.

What then is needed in order that human intelligence may make real for men, in the sense in which it is proper and possible, that universality of culture towards which we ought to strive?

The means of encouraging in the most intimate and fruitful way that mutual mingling of intelligences, would be to unite under the same roof and to invite to a common life, men, devoted to different sciences, already somewhat advanced in their respective studies, but still young enough to have supple minds.

If these young men form bonds of friendship, as is natural between noble and generous hearts in love with higher culture, their life together will not only be charming and a joy, it will bring about insensibly an enlargement of their minds, it will give to each of them an idea of sciences and of methods of intellectual activity which he, by himself, has not the leisure to cultivate, and so it will lead the young men on the road towards that universality of comprehension and of sympathy which is the ideal of human culture.

The creation of a community like the Grad-

uate College of Princeton is a method very happily conceived of solving, so far as the education of the mind is concerned, the great problem already admirably formulated by the Sages of Greece:

Πῶς δέ μοι εἶν τι τὰ πάντ' ἔσται καὶ χωρὶς ἕκαστον;

“What can be done to bring it to pass that the totality of things may be a unit, and, at the same time, each part of it may be a unit?”

For the honor of humanity, as well as for that of the United States of America, I wish success and prosperity for this wise and beautiful institution.



**THE VOCATION OF PHILOSOPHY  
AT THE PRESENT DAY**



# THE VOCATION OF PHILOSOPHY AT THE PRESENT DAY

By ALOIS RIEHL

When you did me the honor of inviting me to deliver an address before this illustrious university upon the occasion of the opening of the new Graduate College, having decided to comply with your request, I could not long remain in doubt as to the choice of a subject. Only a subject of general import seemed to me appropriate to the end in view. For this reason it will be my endeavor to unfold to you a few thoughts on the vocation of philosophy in our time.

A renewed and deepened study of Kant in the concluding third of the last century marks the point at which the philosophical movement of the present day begins. The speculative construction of nature was an adventure which ended in disaster, and by a natural reaction

philosophy found itself, in Helmholtz's words, once more upon a healthy footing in Kant. From its position here it first proceeded to a fresh self-examination. Meanwhile natural science had issued in discoveries and views of philosophical significance, among others the discovery of the Conservation of Energy—the principle which made it possible for the first time to combine all the parts of physics into a single system. The idea of development had been applied to the investigation of organic nature in the doctrine of the Origin of Species. In proportion as scientific research assumed exacter forms it became more and more conscious of the conditions under which it labored. A physiologist of repute spoke of "the limits of our knowledge of nature." Between a natural science grown critical and a philosophy which had made it its principal business to examine the sources and determine the limits of knowledge a rapprochement, which was soon to develop into an alliance, became feasible. Mathematicians and physicists of standing, Ludwig Boltzmann, Henri Poincaré, Ernst Mach and others, following



the example of Helmholtz, took part in the philosophical controversies on the foundations of knowledge. Those two long divided and hostile forces, science and philosophy, did not stop at a mere reconciliation, but went on to establish something in the nature of a confederacy. Yet, promising as was the movement thus inaugurated, and short as is the interval that has elapsed since then, the period of Scientific Philosophy seems to many in our day to be already at an end.

The young generation of the nineties, compared with the preceding, evinced a new spiritual attitude, a change of direction in their thought. Mere science failed to satisfy them. Nietzsche became their spokesman, Life, more exultant Life, their cry. And who would deny them a certain right to this change of view? Science, or what then passed for almost the same thing, natural science, had, one might almost say, over-reached itself. It had extended its claim to dominion beyond its legitimate province—not indeed on the part of its proper representatives but of those who had appropriated its conclusions to dogmatic pur-

poses. Historians, not professional investigators, seriously endeavored to make a natural science of history itself. For them man was a product of his environment. To turn a proverb round, they did not see the trees for the wood, the personal forces of history for the massive groupings of phenomena and their statistics. No, came the rejoinder, science is inhuman. It has as good as nothing to do with us and with the true tendencies of our spiritual life. It cannot take the place of religion. It cannot take the place of art. It only thinks, it does not act. Its kingdom is the dead. In face of its conceptions the living turns to stone.

Where opposing currents meet, the usual course of events is a onesided movement followed by another in the opposite direction. So it happened now. The reaction against Scientific Intellectualism passed beyond the mark. Men went so far as to deny all intrinsic epistemological value to the science of Galileo and Newton, restricting its legitimacy to the sphere of practical and technical application. Once more men began to philosophize *without*

science and *against* science. Once more philosophy bowed the neck to letters, and it is at best as literature that the productions of that movement can be regarded. The conceptions of science were explained as symbols, and in their stead was devised a philosophy of metaphors—in this case veritable symbols. The place of clear and definite thoughts that could be grasped was taken by interpretative feeling, “intellectual sympathy.” Here was the power to transplant us into the inwardness of things, to enable us to lay hold upon the Absolute. This new philosophy of Intuition is in truth nothing but a return of Romanticism to life. Like the former, this Romanticism was a reaction of feeling and imagination against reason and clearness. It was the subjugation of philosophy by poetry. Its significance is that of a genuinely literary epoch. “Creative evolution” is a legend which breathes the very spirit of Romanticism. Against this kind of a philosophy of nature, which is neither philosophy nor natural science, the last word was spoken at a later point in his career by Fichte: “Incapable of basing its

obscure thoughts upon reasons, in place of these it points to the faculty whereby it is carried away, and calls this *intellectual insight*." To-day this faculty is known as intellectual sympathy or intuition.

The opposition to science assumes another form, and one which has preserved itself from all ostensible bias in a romantic direction. Had Pragmatism only aimed at uniting knowledge with life instead of separating it from life, it must have claimed our recognition. As it was it could not overlook the fact that to know also belongs to the life of the spirit, and if knowledge is not the one and only spiritual value, still it has a value of its own. Truth is no mere adjunct to utility. It is not made true because it is useful. It is not *made* at all, not yet invented: it is discovered. We must not be misled by the term *verification*, which is not meant to imply that truths are *made*. Its meaning is that truths are *made good*; and that, not as Pragmatism would have it, by feelings and wishes, but, as natural science shows, by facts which are independent of our liking and of all reference to our interests. In

view of this uncertain and, to some extent, confused position of contemporary philosophy, the search for a criterion by which to estimate its endeavors is indispensable. The way to find this criterion is through an historical consideration of the matter.

Philosophy and science are of simultaneous origin. More exactly, science came to life in the guise of philosophy. Centuries later Aristotle saw in its creation something more than human. Thales and his successors had sought scientific knowledge for its own sake and not for the sake of its utility. Here we see the reason why they thought science alone free and reckoned its possession as something divine—viz., that it does not make utility the object of its pursuit. And we to-day repeat with veneration the names of those early fathers of our men of science and our philosophers, Anaximander, Pythagoras, Heraclitus, Parmenides, and seek through an obscure tradition to catch a glimpse of their personalities. Those thinkers of the pre-Socratic era anticipated all the fundamental conceptions involved in the general scientific view of things, and

thus erected the frame which, it is true, the scientific investigation of following ages was to fill out with a richer content, but which it could not enlarge. For the general points of view from which nature is investigated and which these thinkers discovered one by one—the conception of substance and the quantitative invariability of the given, the subordination of events to law, the mathematical determinateness of phenomena—are derived in the last resort from the constitution of the human spirit which carries out the investigation.

But it was not possible that philosophy should ever be content to remain mere science, else it would not have been philosophy. For the latter applies itself as such not only to the whole of things but also to the whole spiritual life and its creative tendencies.

Socrates, the pedagogical genius of philosophy, discovered in man a spiritual force superior to all the motives of the sensuous nature. He not only discovered this, he lived it out. His life and its culminating act, his death, appear to us, as to the ancients, the revelation of an unconditioned might of the spirit,

the triumph of the clearness of consciousness and of a sovereign will over the instincts.

From the age of Socrates on, philosophy has come to apprehend its scientific mission in a practical sense—that of being an art to guide the spirit and mould the life. It became in consequence a living power, which developed first in the culture of the Greeks, and latterly in the culture of mankind.

In Plato's teaching the two tendencies of philosophy, the theoretical and the practical, enter into a combination which in its completeness has remained the pattern for all succeeding time. If we wish to see ancient philosophy at work in its twofold calling, we must view it at its culminating point, the point which it reached in the Academy founded and directed by Plato. The Academy united in a common life a wide circle of disciples and learners and a narrower circle of investigators and teachers, with Plato at their head. The aim of the association was twofold, the organization of knowledge and the mastery of the forms of life through knowledge—the knowledge of the "Ideas."

In the Academy all the fields of knowledge were systematically investigated from central points of view. Plato in person set their problems to the friends who joined him in research. Thus he introduced the analytic method into the solution of geometrical problems: he gave the initial impetus to the study of solids through his pupil Theaetetus; and to him is due the well-known astronomical problem of estimating, by means of hypotheses, the uniform and regular movements required to keep the phenomena of the planetary movements as they are. The *σώζειν τὰ φαινόμενα*, the demand that phenomena shall be kept intact, is altogether in the spirit of present-day positive science, and is the guiding maxim of our exact investigation. We too endeavor to approach the understanding of reality through mathematical assumptions, comparing the ensuing results with the actual appearances. We too “preserve” phenomena in our scientific investigations.

Just as the Academy occupied a central position in the common work of research, so it speedily became a court of appeal in questions



of government as well. When doubtful issues arose men turned to it for instruction. Plato lived in the conviction that nothing but clear insight into the highest ends of conduct could bring salvation into the affairs of men. From this conviction arose his demand that the rulers of the state should be philosophers.

In the Academy knowledge and moral living were alike placed under the guidance of philosophy.

In modern times also this double calling of philosophy has never been forgotten. Spinoza's philosophy is and is called *Ethics*. It culminates in a more than rational, an intuitive, apprehension of the unity of our spiritual life with the creative substance of the Divine Being, the *actuosa essentia Dei*. Kant distinguishes the "Schulbegriff" of philosophy from its "Weltbegriff." From the former point of view philosophy is "a system of knowledge pursued as science," from the latter, philosophy relates all knowledge to the essential ends of human reason, and in the sense implied in this conception the philosopher is the Lawgiver of Reason and an In-

structor in the Ideal. In more emphatic tones Nietzsche enounces the same thought. The true philosopher, he declares, is a commander and lawgiver. He is one who says: It *shall* be so. With him to know is to create; to create, to issue laws. But it was Fichte above all who revived the Platonic conception of philosophy and the type of the Platonic philosopher. The philosopher, or, as Fichte calls him, the Man of Learning, carries within him in idea the form of the coming age; his life is the very "life of the divine Idea as it makes and unmakes the world." According as this life comes out in action or confines itself to the concept, we have two main classes of philosophers. The first of these Fichte designates the class of rulers—a name which recalls Plato's Archons. To this class belong all those who have the right and the natural call to form an independent judgment and to decide in a way that will hold good, upon the regulation of human affairs. The second class, that of the philosophers or "men of learning" in the narrower sense, falls again into two divisions: a class who educate the

scholars and a class of writers or investigators. It is matter of knowledge how great was the value which Fichte, the orator and edifier of his nation placed upon education. We think instinctively of the meaning of education in Plato's Republic.

But how can philosophy at the present day fulfill the twofold vocation which she once exercised in the Academy? To begin with, how can she solve the problem of organizing knowledge?

The age of the positive sciences has brought with it, along with the increasing separation of the departments of knowledge, an ever advancing division of scientific labour; and no one man can any longer master the sum total of the knowledge of his day, or take upon him to prescribe the problems for investigation. The process of specialization in knowledge, the autonomous development of separate disciplines, is irresistible, and irresistible it needs must be. All the more insistent is the demand which arises, that we should not lose in specialization the consciousness of the unity of all knowledge. The sciences in their total-

ity, as Descartes showed, are nothing else than human knowledge, and this is always one and the same, however different the objects to which it may be applied—just as the light of the sun is one and the same however different the things on which it shines. We have indeed ceased to believe in the possibility of a system of all knowledge which can be rounded off at any one moment. We have even ceased to desire this possibility. Its realization would seem to us like the extinction, the very death, of the motive to knowledge. But in giving up the idea of a system in the sense of a work which, once accomplished, had only to be learnt and passed on, we do not necessarily relinquish system in the sense of a tendency. All *real* knowledge is distinguished from mere knowledge of fact by its inherent inclination for system. It is here that the significance of a theory of knowledge, the significance of a universal doctrine of science, comes into view. Historically too this central philosophical discipline made its appearance and developed as a consequence and demand of the age of the special sciences. Science as such has become

a problem of philosophy. In examining the element of *knowledge* in all we know, and in unearthing the presuppositions involved, epistemology provides positive research with a criterion by which it can judge its work and determine its relation to the sum of knowledge. Every science leads to epistemological problems, and hence the study of these problems is a way by which we may hope once more to achieve the organization of knowledge in these days.

Moreover a kind of Platonic Academy adapted to the altered position of science is even yet possible. I mean the restoration and manifold development of living relations among those who are to carry on the future work of the sciences in different fields. This way the Graduate College has marked out as its own—provided it seeks to create such relations among its sons while they are still learners and at the fresh and receptive age in which the fundamental principles of investigation are customarily set on a firm basis for a whole life of scientific activity.

Still more essential for the present day,

however, appears that other calling of philosophy over and above the theoretical—her call to lead the spirit on the ground that science has made sure.

Our time craves a new spiritual content for life, a rejuvenescence of inward culture. This craving, which no progress of external civilization can satisfy, is met on the side of science by the rising philosophy of history—taking the latter word in the wider sense of a philosophy of spiritual values. Here it is that the philosophy of the present day joins hands with the great tendencies of German Idealism, from which it inherits that most priceless heirloom, a sense for the life of history.

Historically, everything has had its origin in spiritual behavior complicated by reaction with the world of sense. Hence history has not, nor can it have, any existence apart from the life of the spirit. History is time's content: what works through it, what perpetuates itself in it, is not cut off from the present by the form of time. History happens; history *lasts*; of history Bergson's conception of time really holds good. "Objective spirit"—that

term of Hegel's coining, so expressive, so à propos, means more to us than it could have meant to him who first used it. It means not a mere stage in the process of development, but the very essence of history itself. It means that in all outward manifestations of the historical life, taken individually or as a whole, there is a single set of energies at work. Under this enlarged conception of the objective spirit fall alike education, morality, the state and right, religion, art, science. All these are objectivations of the life of the spirit in the field of history.

So far, however, in our treatment of this matter, we have been dealing only with theory. But philosophy is no mere contemplation of life, it is a form of life, it is "objective spirit" itself. The realm of "Ideas" to which it leads us must be not merely known; it must be actualized. Practical principles do not exist in order to be proved; they exist in order to be followed out. Their proof is their power to be the guide of conduct. All science, says Fichte in the same strain, provides grounds for action.

The life of the spirit is by nature an active life. It knows no power that can compel it from without or from above. In all its creations it is the determining agent, carrying its law with it. In knowledge it is the logical postulates and the a priori elements in what we know, which take their rise in the active nature of the spirit; in art it is the dominion of form over matter; in the sphere of moral conduct, the obligation and responsibility imposed by the self; in that of religious experience, the inward conviction of the heart and the voluntary surrender to the divine. In every one of its forms and in all its spheres the life of the spirit is an autonomous life. Freedom through self-imposed laws is its element, the realization of freedom its destination. We think of it as drawn from an original fund of activity deep down in the heart of things. But it has been in the past, and is now being developed through the associations that bind individuals together, the family, society, the state, the religious community. And the consummation is attained in the great personality, who is at once the creator of culture and its highest point.



There exists a system of values. As surely as the Spirit is a living unity, there is a harmony to be created between the fundamental tendencies of the spiritual life. It is the vocation of philosophy as a guide to the spirit, to raise the knowledge of values and of the system of values to the clearness of the concept—to maintain, at whatever cost of struggle and effort, the harmonious disposition of our life.

It was this vocation which, over and above its scientific calling, philosophy fulfilled in days gone by, and this same twofold calling is still its mission to the present day.



**THE PRESENT POSITION OF  
CLASSICAL STUDIES  
IN ENGLAND**



THE PRESENT POSITION OF  
CLASSICAL STUDIES  
IN ENGLAND

BY A. D. GODLEY

The moral of the recent history of classical study in England seems to be that disestablishment—whatever we may think of it in the political world—is not always and everywhere bad for the disestablished. It may at times serve as a salutary tonic. Certainly one may say that the modern development of interest in classical literature dates from about the period—the sixties of the last century—when writers on liberal education proposed to dethrone Latin and Greek from the educational supremacy which they then held, and to substitute the study of modern subjects, more especially natural science. The volume called “Essays on a Liberal Education,” is probably not much read now, and there is no great reason why it should be read,—for our present

guidance, at any rate. As usually happens at the beginning of a controversy, the issues were presented rather crudely, and, in some cases, over-polemically; compromise, not war, was the deciding method later. Some of the suggestions have since been adopted; others have been tried and found wanting. All the questions raised have been fully and freely discussed, and not much is to be gained by going back to their earliest inception.

But one may say parenthetically that this earliest phase of a long controversy has a certain historical interest. It illustrates the admirable optimism of the nineteenth century, more especially that part of it in England which is usually described as the heyday of liberalism. Something or other was always going to be a panacea in those days: something or other, provided always it could be credited to English liberalism, was always going to bring the millennium,—that millennium which nowadays only politicians promise us, and that only because it is part of a politician's business. The 1851 exhibition was going to do it; free competition and "*laissez faire*" was

going to do it; in the more limited sphere of education, it was sometimes comparative philology, and more often science, that held the key to all mental elevation. And in the sixties thoughtful men imagined that the world was to be regenerated—in the true spirit of the sadly iconoclastic liberalism of those days—by getting rid of a classical education. At least, that was the way these early controversialists put it, in their first fine, careless rapture. The time for half measures and compromises was not yet. Probably they felt that the best way to inaugurate reform was to attack with more vehemence than was really right and necessary; to strike a little harder than they need in order that they might have a stronger position in the day of negotiation. What they really meant to do, and what the fairest of their critics read between the lines, was not to expel but to equalize; to assert the right, too much neglected at that time, of other subjects; to give modern things, as well as Latin and Greek, their place in the sun.

Well, it is needless to point out that that place in the sun has been very amply con-

ceded. The whole fabric of European and American education bears testimony to that. Science and modern languages have so many of the rooms on the south side that the classics now have to put up with the cold shade of neglect. They have been, educationally, disestablished; they have been ousted from their proud supremacy; but it looks as if disestablishment had made classical teaching more energetic than ever, and given it stronger claims on popular sympathy. It is difficult to speak of cause and effect here. I do not know whether it would be an insult or a compliment to teachers of the classics to suggest that they were intimidated by the threats of essayists into setting their house in order and infusing more life into their instruction: it would be a compliment to their adaptability and power of dealing with circumstances, but it might be a reflection on the character which needed the stimulus of terror to achieve its full perfection. It is better, I think, to take the safe ground of showing that the English-speaking world was at that particular period really ripe for a new start in the matter of Latin and Greek.



Probably the forces which made for attack, differently applied, made also for defence. Growing wealth and increasing population, and the levelling up of a democratic period, meant more schools and colleges; and more schools and colleges meant the direction of a greater variety of minds to the subjects of education, and a consequent tendency to strike out new lines. And, granting that the classics were still to be studied, work must find something new to its hand. The older scholars, the Bentleys and Porsons, the Lachmanns and Hermanns, the Gaisfords and Linwoods later, had done the necessary pioneer work in the constitution of the texts of the great classics, and the Munros and Mayors and Coningtons had continued the opening up of the routes. Grammarians who

settled *Hotis* business—let it be!

Properly based *Oun*—

Gave us the doctrine of the enclitic *Ge*,

Dead from the waist down,

had left indeed much that could be done, and has been nobly done by the Jebbs and Ellises and Goodwins who came a little later; but the

field of possibilities within the sphere of the greatest classics was certainly diminished. To speak in the language of an Alpinist, the great peaks had been won: the routes to them were clear, as regards their main lines: succeeding climbers must go farther afield, or invent new routes,—just as the De Saussures and the Leslie Stephens have made it necessary for the modern mountaineer, who wants to associate something memorable with his name to try how near he can go to breaking his neck. And the direction of new lines was indicated.

Whatever judgments the twentieth century may pass on the nineteenth—and it seems that they are pretty severe, at least in England—even the ardent spirits of to-day will not deny that ever since the Romantic movement one guiding motive was to get right away from cant and convention, and see things as they are, steadily and whole. One sees that in fiction, in Dickens and Thackeray and George Eliot. One sees it in the changed spirit which has come over historical research in the last forty years, and has made history so

much duller reading than it used to be, because the historian's object is now merely to arrive at the truth, while it used to be to annoy his political opponents. Poetry has great difficulties with that problem, and painting too. And I do not say that as the century progressed to its end this meritorious attempt has not produced some remarkable and not wholly pleasing results; but it is not to be denied that the development of "realism" in fiction coincided roughly in time with the endeavour to read newer and truer meanings into a classical literature which was accepted as a matter of course from its very familiarity. People began to suspect a real humanity—something nearer to ourselves, and naturally explainable—in what was before regarded as a direct and somewhat inhuman emanation from Parnassus. What our rude forefathers easily accepted began to bristle with problems. Homer, of course, became a mere playground for critics and theorists in England, as he had long been on the continent of Europe. Thucydides had been the model historian, and Herodotus the father of lies. Now, I under-

stand, on a poll of scholars it is Thucydides who would get most votes for deliberate mendacity, for Herodotus' character seems to have been, on the whole, reëstablished. And Horace, whom our ancestors thoughtlessly recited in youth and pretended to read for pleasure in mature age, was seen to be as full of cypher phrases and hidden meanings as Shakespeare under the lens of a Baconian. Whatever the conclusion, the fact remains that scholars are reading the classics with opener minds and a more awakened attention. No wonder; for the great archaeological discoveries, besides being in themselves profoundly interesting, were shedding new light on Greek literature, and placing the Greek of historical and legendary times in a wholly different position. What has been regarded as gratuitous invention appeared now as an echo from an earlier world—the adornment and transmission of dim, prehistoric stories; Greece was an intermediary between us and the earlier civilization of Cnossos and Mycenae and the Troad. Nothing could supply better food for the imagination. Altogether, with the open-

ing of new vistas, Greek history and Greek scholarship became a much more exciting business than it had been in the old days when Thucydides was presented to schoolboys and undergraduates as a series of exercises in syntax, and Greek tragedy formed the mind by a study of metrical rules and exceptions.

Far be it from me, or from any English critic, to decry or disparage the "grand old fortifying classical curriculum." It has played its part, and a very important one, in English education, and, one may really say, in the making of English history. For a long time classical culture, as it was understood, represented practically the whole of the secondary education enjoyed or suffered by our governing classes. And least of all ought an Oxonian to speak lightly of it; for its earliest habitat was in the university, and I think I may say especially in the University of Oxford. It was there, I mean, that some knowledge of Greek and Latin began to be associated with the status of a gentleman; and both the status of a gentleman and the study of Latin and Greek have been variously affected by it. The

eighteenth century is an unpopular period—even now, when the nineteenth, which was always cavilling at it, is itself falling into some disrepute—and one does not readily associate beneficent changes with it, least of all in the University of Oxford, which has been supposed to represent the eighteenth century at its worst and blackest. Nevertheless, this maligned period was the parent of many reforms, or changes, for which the nineteenth century afterwards got the credit; and one of these was certainly a great change in the condition of universities. Educationally and socially, Oxford was profoundly modified; and it was the coincidence of the educational with the social alternative which brought about the state of things with which one is familiar.—the idea of the classics being a necessary part of the education of a gentleman. The middle of the century found Oxford, one may say, with no university curriculum of any profitable kind. There were exercises for a degree; but they consisted mainly in the repetition of stock formulae, founded on the logic of the mediaeval schoolmen. Practically, so far as the univer-

sity was concerned, a man might leave Oxford as ignorant of literature as he had come to it. It is very creditable to the college teachers of that day that, with no encouragement but their own sense of what was right and proper, they did inaugurate a kind of classical renaissance. It was not a period, I think, of profound or abstruse classical learning. But young men were encouraged to read a good deal of the great authors, and elegant scholarship was cultivated. Colleges competed with each other in the making of Latin verses, an art which indeed had an early popularity even in Oxford. It was all part of the civilizing process, and came all the more naturally as such, because it happened that about 1750, or so, the Oxford colleges were becoming, for good or evil, in great measure "Finishing Academies for Young Gentlemen," at any rate were becoming much more the special preserve of the so-called upper classes than had previously been the case. So it was that, as many colleges catered for the governing classes, the governing classes came to reckon elegant scholarship as their own peculiar attribute.

When Gibbon, in the rather grudging palinodia in which he takes back some part of his attack on the university (founded, it should be remembered, on some very juvenile impressions of a short residence at Magdalen),—when Gibbon says that learning has become “a duty, a pleasure, and even a fashion,” it is noticeable that the foundation to which he is especially referring is Christ Church, then, as afterwards, the special training-ground for sprigs of nobility, and those who wish to cultivate the society of “the great.” Such were the early days of classical scholarship at Oxford; and this kind of revival was fixed and stereotyped when the university, at the beginning of the nineteenth century, established its first honor examination. Classical scholarship was duly recognized from the earliest beginning of a *Litterae Humaniores* examination; though some critics considered that the Aristotelian logic should have been ousted altogether instead of being left as a partner to literature. Anyhow, such knowledge of Greek and Latin as sufficed for the gaining of a class at Oxford was now endowed with additional



prestige, because academic honors were recognized as a sure road to later success. In political and ecclesiastical circles especially, young men who had distinguished themselves at the university were much in demand. Greek scholarship, as it has been said, led not only to knowledge of the means of salvation in the next world, but to positions of emolument in this. Fellows of colleges who wanted church preferment edited Greek plays. I fear bishops have other qualifications now. In and outside the church some sort of classical knowledge was the appanage of the governing classes. In "Friendship's Garland" M. Arnold depicts the Rev. Esau Hittall, the sporting parson of the mid-Victorian era, whose claims to culture rested on a legendary copy of verses ("longs and shorts") on the Calydonian boar. If a man had no other considerable claims to respect, he was, if an elegant scholar, entitled to look down on those who, like Shakespeare, had small Latin and less Greek. You may remember Thackeray's somewhat ungentle picture of a Fellow of a College, often drunk and quite useless to the world (as Thackeray says) when

sober, who still considers that he is something above ordinary mortals because he can turn anything in the world into Greek iambs.

So classical culture was the fashion; parliamentary oratory was tricked out with classical quotations; the House, less candid, or less virtuous than ours, must at least pretend to understand its Virgil and Horace. The second Aeneid, I have been told, furnishes the great majority of the Latin parliamentary quotations. Mr. Gladstone, in his day the typical, brilliant young politician, fresh from the triumphs of the schools, continued the habit of quotation through his life; and I have heard it said that he was the only speaker who in his later years could venture to quote Greek in the House. We have changed all that now. Perhaps their association with a ruling clique has given the classics an unpleasant flavor of aristocracy. Perhaps a knowledge of extinct and mysterious tongues implies sinister designs. Anyhow, for whatever reason, an acquaintance with even Latin and *a fortiori* Greek is supposed to corrupt democratic virtue. It is a fact that Greek literature is singularly out-

spoken, and plain speaking is not always agreeable to democracies,—English democracies, I mean, of course.

Now-a-days, the old undisputed prerogative of a classical education is extinct. Classical study is fighting for its life, with very creditable success, so far, and, as I said, the exercise is quite good for its muscles. Naturally, no result has been achieved which one can consider permanent. There is no finality, fortunately, in educational matters. But it is perhaps worth while to register the state of things at this particular moment in England. So far the result of the battle amounts to this: in nearly all secondary schools, Latin maintains its position as a necessary part of the curriculum. It is for the moment fairly secure. The Homeric combats of to-day rather centre round Greek. The modern sides of our public schools do not teach Greek; and from many secondary schools it has been banished altogether. In the universities, its fate trembles in the balance. Most of the newer foundations have settled the matter for the present: their students may begin and continue

Greekless. Oxford and Cambridge still stand firm and make some modicum of Greek a necessary part of their initial examination. This is not always a popular attitude. During the battle which has been raging now intermittently for ten years and more, we have been told the truth about ourselves with remarkable candor, and our future has been painted in very lurid colors. We are the homes of dead languages and undying prejudice. We are obstacles in the path of progress. Multi-millionaires will not assist our poverty, and eventually the State will make a clean sweep of our colleges, and start us afresh on lines more in harmony with the best traditions of democracy. These threats are backed up by the sweetly reasonable and enlightened persons who love Greek so much that they cannot bear to associate it with a compulsion which runs counter to our finer instincts; nobody, in fact, ought to be compelled to learn anything,—except perhaps a little mathematics. And compulsion, they say, is quite unnecessary; for they refuse to believe that the world will ever not wish to learn Greek. Somehow or other

advocacy of compulsory Greek has come to be identified with a reactionary obscurantist habit of mind. I have heard it said, "so and so is a Liberal in politics: very strange that he should be in favour of retaining Greek in Responsions!" Political terms are strange things in their use and abuse. In England Liberal is a political term, liberal is a moral one: but what of that? It is only to be expected that we should get credit for liberality, when it is only Liberalism after all.

The defenders of compulsory Greek at Oxford (and I suppose I may speak for Cambridge too) are not all of them merely hidebound pedants, timid reactionaries, dull obscurantists. They hardly look forward to a period when the British workman will demand a knowledge of Greek with the same enthusiasm as that with which he now demands beer. But they do hold that our civilization would suffer if Greek ceased to be fairly widespread and became the study of a few savants, like Sanskrit. They see that Greek suffers in schools (in some, perishes altogether) where it is not supported by universities; and they

see, too, that when Greek goes Latin is apt to go too. It is, of course, impossible that all universities should include Greek in their examinations, as of course it is neither possible nor desirable that all schools should teach it. But it does need protection. "There are few studies which it would be so easy to lose as that of Greek, few which it would be so hard to regain" (Conington); and that protection can only be given by Oxford and Cambridge. In these circumstances Oxford and Cambridge still insist on Greek. But let the facts be noted: one often hears garbled accounts. Greek is only, for everyone, a part of the initial examination,—an examination which can be passed before the candidate comes into residence at Oxford. After that, the passman, the man who aims at no academic honors, must certainly offer the classics as part of his curriculum; but the honors man need never open a Greek or Latin book during the whole period of his residence. Thus the much-abused "burden of Greek" does not weigh very heavily on the student. A natural science candidate must certainly get up an acquaintance

with a couple of Greek plays or so, and a little Greek grammar. But he can do this before he comes into residence; once at Oxford he can devote himself entirely to any "ology" that he pleases, without further interruption. And some of his most eminent leaders say that the interruption, such as it is, does him no harm, but rather good. These are thorny subjects.

The controversy has really been creditable to both sides. It shows, after all, how zealous we are about education, and that is the great thing; and if universities have come in for hard knocks, they have only to expect it: suffering is the badge of all their tribe. I should not leave this subject without acknowledging the great help which the "defenders of Greek" have received from America,—sympathy shown in printed words or *viva voce*. Especially, coming as the help does from that country, it has done a great deal to show that the cause is not one of irrational, pig-headed conservatism.

We may claim, as I said, to have in view the wide dissemination of some sort of Greek culture,—Greek for science men is one way to

that. Another, and a less controversial method, is to popularize the classics educationally by doing what we can to adopt our classical curriculum to the needs of the average man, who is not going to be a specialist in any particular line of study. We have him to think of,—perhaps even more than the serious student. And for him, what is a classical curriculum? One is at once confronted with a number of excellent maxims, all applicable to the matter in hand, and for the most part mutually destructive: a little knowledge, says one, is a dangerous thing: *πλέον ἤμισυ πάντος* and *μηδὲν ἄγαν* says another. “Good are the Ethics, I wis: good absolute: not for me though”—says the not very serious student in A. H. Clough’s poem. Things absolutely excellent may be relatively embarrassing. While the productivity of our writers on classical subjects is an excellent thing, and the examination system if not excellent, appears to me for the present to be indispensable,—yet inconveniences arise from both. There is the danger, for the average student of the classics at our schools and universities, of a kind of in-



tellectual indigestion produced by a too rash indulgence in the pleasures of the library. He wants to have some kind of knowledge of part of Greek and Roman literature, some acquaintance with the best that antiquity can give him; and it is all served up to him in a highly attractive and stimulating form. So many master hands are employed in cooking the classics for him; there are so many books, English and American, which are delightful to read, and so many lecturers who present the theories of the learned in an interesting way, like powder in jam; new lights on Aegean civilization, new lights on Homer and Virgil, brilliant literary appreciations of Greek tragedy,—any one might be beguiled by them, and, of course, it is all to the good. The classics have no doubt been enormously popularized. But a classical curriculum ought not to mean, primarily, reading translations, or books about books: all the “Realien” and all the brilliant speculations in the world are not quite the same thing, do not give the same mental exercise, as reading the classics for one’s self: and life is so short. One realizes the

brevity of life especially when sixth-form masters, themselves interested in modern research and criticism, try to give their pupils some idea at second hand of what is going on in the intellectual firmament where professors live,—where they lie (or at least develop pleasing hypotheses) beside their nectar, and hurl bolts at one another.

Once you embark on that “Cretan sea” of theories about Aegean civilization, or the inner meaning of Horace, or the relation of Euripides to Athenian literary coteries, you are in an atmosphere of controversial statements and somewhat enterprising logic which is rather too rarefied for the young. They have not the means of judging between the learned: the collation, the cold collation, of rival theories is strong meat for babes. Is it even quite right for young students, not yet sure of themselves in mathematics and logic, to move in a world where two plus two sometimes equal five (or, let us optimistically say, four and one half) and knowledge advances by a bold use of the *petitio principii*? Personally I cannot but think it is rather a pity that there is a

tendency to disparage composition in the dead languages, to sacrifice it to general reading about them. Latin verse-making may produce, as Dean Farrar said, a "finical fineladyism of the intellect"; it may be an exotic which flourishes most luxuriantly in the thin artificial soil of vain and second rate minds: but at least it does teach a knowledge of the language.

If too much reading of books about books is not an unmitigated blessing, still less is it so when the end and object of reading is an examination. Getting up facts for examination purposes is rather a weary business; cramming theories has really nothing to be said for it; and cramming some one else's literary appreciation is the worst of all. There is this great justification of the examinational system,—that it shows a man at his worst and protects the public by destroying any illusions about him. And if papers of questions are not well adapted to a course of general reading about classical antiquity, what is to be said about their relation to specialized studies and "intensive culture"? One need not enlarge on

the miscellaneous activities of modern specialism,—especially in America,—on the admirable seminar system, and the microscopic industry which is filling the world of to-day with such a multitude of monographs. Nobody can regard otherwise than with admiration the immense industry which our rising generation of students is putting into classical research,—provided always that the youthful specialist, in his passion for intensive culture, gives himself time enough to acquire that competent knowledge of Latin and Greek, and that general acquaintance with ancient history, without which his researches lose some of their value. Seminar work is premature when a man does not yet know Greek. But here, again, we are face to face with the examination system. Examination papers are set by examiners who are only human (even if the candidate holds a different opinion at times) and naturally welcome the opportunity of showing that they too are acquainted with those monuments of erudition which choke their waste-paper baskets. Anyhow, it is only natural that the specialist should set the pace, and the candidate who is not a

specialist has to keep up as well as he can. Now it is eternally creditable to a student to ascertain by his own careful research precisely, let us say, how many times *καί* occurs in Thucydides. He has gone through an exercise which could hardly be bettered by a treadmill, and at least he has read his Thucydides. But there is very little mental or moral elevation to be gained from acquiring from some one else's labors the result of those investigations in a tabulated form. The important thing is that as large a number as possible of intelligent men should be trained in the classics; but they will not begin to do this if they are to be forced into a specialism which is uncongenial to them, and because it is uncongenial, and, for them, leads to nothing, will never be of any profit. It is well that universities should insist on teaching what the world calls useless; but there are different kinds of inutility, some profitable and some not.

However the classics may be popularized for cultured circles in the world, in universities and schools they are, I think, endangered by

the wholly admirable activities of their teachers. We have our *Classical Review* and *Classical Quarterly*; we have our Classical Associations; but we are in danger of dragging the average man too uncomfortably at our chariot-wheels. If we want to protect ourselves against the people who make a great outcry about schoolboys giving too much time to the classics,—time which should be wholly devoted, they say, to useful subjects,—I should suggest very humbly that teachers of the higher classes in schools forget for the moment the demand of the future palæographer and archæologist. He will look after himself in due course. They should really shorten the hours of instruction in Latin and Greek, and content themselves with a thorough grounding in the elements of both languages, as well as, of course, in the broad lines of ancient history; and a thorough grounding in the languages I take to include practice in Latin and Greek composition, which is to my mind, for most boys, a much pleasanter, more stimulating, and more educative exercise than hearing about the theories of the learned.

*Given good teaching*, a sufficient familiarity with the languages might, one would think, be imparted without taking up a disproportionate amount of school time. Then let the boy who elects to take up classics at his university as a subject for his degree not be encouraged to cover quite so much ground as he attempts—under the stress of examinations—at present; let him broaden his studies, of course, but only carry them (like Mr. Casaubon) up to a certain point: not being introduced to the world of advanced study and research till he has taken his degree. Then is the time for him to judge between Minoan and post-Minoan, and to embark on such archaeological or palæographical exercises as captivate his fancy: exercises which are delightful and profitable for the real student, but which should be kept as long as possible—until they show results which are really important to our understanding of classical literature—out of the cold atmosphere of examinations. But it is to the researches of our trained specialists that we look for the advancement of learning; and those universities which recognize the value

of graduate work and its distinction from an undergraduate course are best serving that great cause. Never was classical culture so popular. It is for us so to direct it that it may inspire indeed the industry of the savant, but, what is more important, may be not dis severed from the life of the nation.



**THE REVIVAL OF SCIENCE IN THE  
SEVENTEENTH CENTURY**



# THE REVIVAL OF SCIENCE IN THE SEVENTEENTH CENTURY<sup>1</sup>

BY ARTHUR E. SHIPLEY

With one or two exceptions—astronomy on the physical side, human anatomy on the biological—the reawakening in science lagged a century or more behind the renaissance in literature and in art. What the leaders of thought and of practice in the arts of writing, of painting and of sculpture in western Europe were effecting in the latter part of the fifteenth and throughout the sixteenth century began to be paralleled in the investigations of the physical laws of nature only at the end of the sixteenth century and throughout the first three quarters of the seventeenth.

Writing broadly, we may say that, during the Stewart time, the sciences, as we now class

<sup>1</sup>This address, revised and enlarged, formed part of a chapter in the eighth volume of *The Cambridge History of English Literature*.

them, were slowly but surely separating themselves out from the general mass of learning, segregating into secondary units; and, from a general amalgam of scientific knowledge, mathematics, astronomy, physics, chemistry, geology, mineralogy, zoology, botany, agriculture, even physiology (the offspring of anatomy and chemistry) were beginning to assert claims to individual and distinct existence. It was in the Stewart reigns that, in England at any rate, the specialist began to emerge from those who hitherto had "taken all knowledge to be" their "province."

Certain of the sciences, such as anatomy, physiology and, to a great extent, zoology and botany, had their inception in the art of medicine. But the last two owed much to the huntsman and the agriculturist. During the preceding century, the great Belgian anatomist Vesalius had broken loose from the bond of the written word which had strangled research for a thousand years, and had looked at the structure of the human body for himself; he taught what he could himself see and what he could show to his pupils. Under him, anatomy

was the first of the natural sciences to break loose from the scholastic domination which had hitherto ever placed authority above experiment.

As anatomy on the biological side, so astronomy on the physical, led the way. Copernicus had claimed that the sun was the center of our system; but it was not until the following century, when the truth of his views was mathematically proved, that, first, men of science, and, later, the world at large, abandoned the views of Ptolemy, which, like those of Aristotle, of Galen and of Hippocrates, had obsessed the learned world since classical times.

The great outburst of scientific enquiry which occurred during the seventeenth century was partly the result, and partly the cause, of the invention of numerous new methods and innumerable new instruments, by the use of which advance in natural knowledge was immensely facilitated. Early in the century (1614), Napier of Merchiston had made known his discovery of logarithms, and logarithmic tables were first published in 1617. Seven years later, the slide rule, which today

plays a large part in physical and engineering science, was invented by Edmund Gunter. Decimals were coming into use and, at the close of the sixteenth century, algebra was being written in the notation we still employ. William Gilbert, physician to Queen Elizabeth, published his experiments on electricity and magnetism in the last year of the sixteenth century. Galileo was using his newly constructed telescope; and, for the first time, Jupiter's satellites, the mountains in the moon and Saturn's rings were seen by human eye. The barometer, the thermometer and the air pump, and, later, the compound microscope, all came into being at the earlier part of our period, and by the middle of the century were in the hands of whoever cared to use them. Pepys, in 1664, acquired

a microscope and a scotoscope. For the first I did give him £5. 10. 0, a great price, but a most curious bauble it is, and he says, as good, nay, the best he knows in England. The other he gives me, and is of value; and a curious curiosity it is to discover objects in a dark room with.

Two years later, on 19 August 1666 "comes by agreement Mr. Reeves, bringing me a lan-

tern"—it must have been a magic lantern—  
“with pictures in glass, to make strange things  
appear on a wall, very pretty.”

As we pass from Elizabethan to Stewart times, we pass, in most branches of literature, from men of genius to men of talent, clever men, but not, to use a Germanism, epoch-making men. In science, however, where England led the world, the descent became an ascent. We leave Dr. Dee and Edward Kelly, and we arrive at Harvey and Newton.

The gap between the medieval science which still obtained in Queen Elizabeth's time and the science of the Stewarts was bridged by Francis Bacon, in a way, but only in a way. He was a reformer of the scientific method. He was no innovator in the inductive method; others had preceded him, but he, from his great position, clearly pointed out that the writers and leaders of his time observed and recorded facts in favour of ideas other than those hitherto sanctioned by authority.

Bacon left a heritage to English science. His writings and his thoughts are not always clear, but he firmly held, and, with the au-

thority which his personal eminence gave him, firmly proclaimed, that the careful and systematic investigation of natural phenomena and their accurate record would give to man a power in this world which, in his time, was hardly to be conceived. What he believed, what he preached, he did not practise. "I only sound the clarion, but I enter not into the battle"; and yet this is not wholly true, for, on a wintry March day, 1626, in the neighborhood of Barnet, he caught the chill which ended his life while stuffing a fowl with snow, to see if cold would delay putrefaction. Harvey, who was working whilst Bacon was writing, said of him: "He writes philosophy like a Lord Chancellor." This, perhaps, is true, but his writings show him a man, weak and pitiful in some respects, yet with an abiding hope, a sustained object in life, one who sought through evil days and in adverse conditions "for the glory of God and the relief of man's estate."

Though Bacon did not make any one single advance in natural knowledge—though his precepts, as Whewell reminds us, "are now



practically useless"—yet he used his great talents, his high position, to enforce upon the world a new method of wrenching from nature her secrets and, with tireless patience and untiring passion, impressed upon his contemporaries the conviction that there was "a new unexplored Kingdom of Knowledge within the reach and grasp of man, if he will be humble enough, and patient enough, and truthful enough to occupy it."

The most sublime of English poets survived our period by a few years. A comparison between Dante's and Milton's great epics affords some indication of the advance in knowledge of this world and in the outlook on a future state which measures the progress made between the Middle Ages and the seventeenth century. As a poet (and, indeed, often in other activities of his life) Milton stood above, or at least, outside, the stream of tendency of the times through which he lived. Yet, in his poems (not in his political tractates—the most ephemeral of all literature) we see effects of the rising tide of science on literature.

Milton, one must never forget—and indeed,

it is not easy to do so—was, for some years, a schoolmaster. He took a view of his profession which even now would be thought liberal; he advocated the teaching of medicine, agriculture and fortification, and, when studying the last of these, remarked that it would be “seasonable to learn the use of the Globes and all the maps.” Like Lord Herbert of Cherbury, he held that the student should acquire some knowledge of medicine, he should know “the tempers, the humors, the seasons and how to manage a crudity.” Himself, a sufferer from gout, he learnt, at any rate, the lesson of moderation. Mathematics, in his curriculum, led to the “instrumental science of Trigonometry and from thence to Fortification, Architecture, Enginery or Navigation.”

At the time of the writing of *Paradise Lost*, the learned had accepted the theory of Copernicus, although the mathematical proof afforded a few years later by Newton was still lacking. But the world at large still accepted the Ptolemaic system, a system which, as a schoolmaster, Milton taught. Mark Pattison has pointed out that these two

systems confront each other in the poem, in much the same relative position which they occupied in the mind of the public. The ordinary, habitual mode of speaking of celestial phenomena is Ptolemaic;<sup>2</sup> the conscious or doctrinal exposition of the same phenomena is Copernican.<sup>3</sup>

But the incongruity between these two statements is no greater than will be found today in authors writing of subjects still *sub judice*. Further, we must not forget that Milton never saw either of his great epics in writing or in print. His power of impressing his visions on the world was, however, such that Huxley held that it was not the cosmogony of *Genesis* but the cosmogony of Milton which had enthralled and misled the world.

More distinctly than in his epics, Milton, in his history, showed a leaning to the scientific method. Firth has lately told us that "his conclusions are roughly those of modern scholars, and his reasoning practically that of a scientific historian." In one respect, however, he was less than lukewarm. He had no sym-

<sup>2</sup> Mark Pattison cites *Paradise Lost*, VII, 339-356; III, 420-481. And yet, in 1639, Milton had visited Galileo.

<sup>3</sup> See *ibid.* VIII, 77, 122-140.

pathy with antiquarian researches and sneered at those "who take pleasure to be all their lifetime raking the foundations of old abbeys and cathedrals."

To turn to other evidence, the better diaries of any age afford us, when faithfully written, as fair a clue as do the dramatists of the average intelligent man's attitude towards the general outlook of humanity on the problems of his age, as they presented themselves to society at large. The seventeenth century was unusually rich in volumes of autobiography and in diaries which the reading world will not readily let die. The autobiography of the complaisant Lord Herbert of Chisbury gives an interesting account of the education of a highly-born youth at the end of the sixteenth and the beginning of the seventeenth century. Lord Herbert seems to have had a fair knowledge of Latin and Greek and of logic when, in his thirteenth year, he went up to University College, Oxford. Later, he "did attain the knowledge of the French, Italian and Spanish languages," and, also, learnt to sing his part at first sight in music

and to play on the lute. He approved of "so much logic as to enable men to distinguish between truth and falsehood and help them to discover fallacies, sophisms and that which the schoolmen call vicious arguments"; and this, he considered, should be followed by "some good sum of philosophy." He held it also requisite to study geography, and this in no narrow sense, laying stress upon the methods of government, religions and manners of the several states as well as on their relationships *inter se* and their policies. Though he advocated an acquaintance with "the use of the celestial globes," he did "not conceive yet the knowledge of judicial astronomy so necessary, but only for general predictions; particular events being neither intended by nor collected out of the stars." Arithmetic and geometry he thought fit to learn, as being most useful for keeping accounts and enabling a gentleman to understand fortifications.

Perhaps the most characteristic feature of Lord Herbert's acquirements was his knowledge of medicine and subjects allied thereto. He conceived it a "fine study, and worthy a

gentleman to be a good botanic, that so he may know the nature of all herbs and plants." Further, "it will become a gentleman to have some knowledge in medecine, especially the diagnostic part"; and he urged that a gentleman should know how to make medicines himself. He gives us a list of the "Pharmacopaeias and anechodalties" which he has in his own library and certainly he had a knowledge of anatomy and of the healing art—he refers to a wound which penetrated to his father's "pia mater," a membrane for a mention of which we should look in vain among the records of modern ambassadors and gentlemen of the court. His knowledge, however, was entirely empirical and founded on the writings of Paracelsus and his followers; nevertheless, he prides himself on the cures he effected, and, if one can trust the veracity of so self-satisfied an amateur physician, they certainly fall but little short of the miraculous.

John Evelyn, another example of a well-to-do and widely cultivated man of the world, was acquainted with several foreign languages, including Spanish and German, and was in-

terested in hieroglyphics. He studied medicine in 1645 at Padua, and there acquired those "rare tables of veins and nerves" which he afterwards gave to the Royal Society; attended Le Felure's course of chemistry at Paris in 1647; was skilled in more than one musical instrument, learned dancing and, above all, devoted himself to horticulture.

When travelling abroad, he made a point of visiting the "cabinets" of collectors, for, at that time, public museums, which, in fact, grew out of these cabinets, were non-existent. The following quotation records the sort of curiosities at which men marvelled in the year 1645:—

Feb. 4th. We were invited to the collection of exotic rarities in the museum of Ferdinando Imperati, a Neapolitan nobleman, and one of the most observable palaces in the city, the repository of incomparable rarities. Amongst the natural herbals most remarkable was the *Byssus marina* and *Pinna marina*; the male and female cameleon; an *Onacratulus*; an extraordinary greate crocodile; some of the *Orcades Anates*, held here for a great rarity; likewise a salamander; the male and female *Manucodiata*, the male having an hollow in the back, in wch 'tis reported the female both layes and hatches her egg; the man-

dragoras of both sexes; Papyrus made of severall reedes, and some of silke; tables of the rinds of trees written wth Japoniq characters; another of the branches of palme; many Indian fruities; a chrystal that had a quantity of uncongealed water within its cavity; a petrified fisher's net; divers sorts of tarantulas, being a monstrous spider with lark-like clawes, and somewhat bigger.

But Evelyn's chief contribution to science, as already indicated, was horticultural. He was devoted to his garden, and, both at his native Wotton, and, later, at Sayes court, Deptford, spent much time in planting and planning landscape gardens, then much the fashion.

In the middle of the sixteenth century, the fact that "nitre" promoted the growth of plants was beginning to be recognised. Sir Kenelm Digby and the young Oxonian John Mayow, experimented *de Sal-Nitro*; and, in 1675, Evelyn writes: "I firmly believe that where saltpetre can be obtained in plenty we should not need to find other composts to ameliorate our ground." His well-known *Sylva*, published in 1664, had an immediate and a wide-spread effect, and was, for many years, the



standard book on the subject of the culture of trees. It is held to be responsible for a great outbreak of tree-planting. The introduction to Nisbet's edition gives figures which demonstrate the shortage in the available supply of oak timber during the seventeenth century. The charm of Evelyn's style and the practical nature of his book, which ran into four editions before the author's death, arrested this decline ("be aye sticking in a tree; it will be growing, Jock, when ye're sleeping" as the laird of Dumbiedykes counselled his son), and to the *Sylva* of John Evelyn is largely due the fact that the oak timber used for the British ships which fought the French in the eighteenth century sufficed, but barely sufficed, for the national needs.

Pepys, whose naïve and frank self-revelations have made him the most popular and the most frequently read of diarists, was not quite of the same class of student to which Lord Herbert of Cherbury or John Evelyn belonged. But, gifted as he was with an undying and insatiable curiosity, nothing was too trivial or too odd for his notice and his record;

and, being an exceptionally able and hard-working government servant, he took great interest in anything which was likely to affect the navy. He discoursed with the ingenious Dr. Kuffler "about his design to blow up ships," noticed "the strange nature of the seawater in a dark night, that it seemed like fire upon every stroke of the oar"—an effect due, of course, to phosphorescent organisms floating near the surface—and interested himself incessantly in marine matters. His troubled eyesight and his love of music account for the attention he paid to optical appliances, the structure of the eye, musical instruments of every kind and musical notation; for this last, he seems to have invented a mechanical means of composing which is still preserved at Magdalene College, but which no one now quite understands.

Physiology and mortuary objects had, for him, an interest which was almost morbid. He is told that "negroes drowned look white, and lose their blackness, which I never heard before," describes how "one of a great family was . . . hanged with a silken halter . . . of his

own preparing, not for the honour only” but because it strangles more quickly. He attended regularly the early meetings of the Royal Society at Gresham College, and showed the liveliest interest in various investigations on the transfusion of blood, respiration under reduced air pressure and many other ingenious experiments and observations by Sir George Ent and others. On 20 January 1665, he took home *Micrographia*, Hooke’s book on microscopy—“a most excellent piece, of which I am very proud.”

Although Pepys had no scientific training—he only began to learn the multiplication table when he was in his thirtieth year, but, later, took the keenest pleasure in teaching it to Mrs. Pepys—he, nevertheless, attained to the presidentship of the Royal Society. He had always delighted in the company of “the virtuosos” and, in 1662, three years after he began to study arithmetic, he was admitted a fellow of their—the Royal—Society. In 1681, he was elected president. This post he owed, not to any genius for science, or to any great invention or generalisation, but to his

very exceptional powers as an organiser and as a man of business, to his integrity and to the abiding interest he ever showed in the cause of the advancement of knowledge.

If we pass from the interest taken in scientific progress by men of superior intelligence to the obstacles opposed to it by popular ignorance and superstition, we are brought face to face with the long-lived crew of witches, wizards and alchemists. It is often said that the more rationalistic outlook of the seventeenth century, due to Hobbes and others, did much to discredit these practitioners. But the observant dwellers in our British cities or remote country villages, pestered as they are with advertisements of those who practise palmistry, and of those who predict the future by crystal-gazing or by the fall of sand, of followers of the sporting prophet, and of far more presumptuous and more dangerous impostors, or confronted by the silent, indomitable belief of the rustic in the witchery of his ancestors, may well hold the opinion that the stock of superstition is a constant stock and permeates now, as it did in Elizabeth's time,

every class of society. What improvement there was in the seventeenth century, and it is extremely doubtful if there was much, was largely due to the advent of James I and the later rise of puritanism, associated as they were with the most cruel and most inhuman torture of sorcerers. When the alchemist and the astrologer ran the risk of suffering as a sorcerer or a warlock, he paused before publicly embarking on that trade.

Under the Tudors, the laws against witchcraft were milder than those of other countries, but, under James I, these laws were repealed and he himself took—as he had done before in Scotland—an active part in this cruel and senseless persecution. During the first eighty years of the seventeenth century, no less than 70,000 men and women are said to have been executed for alleged offences under the new act. The king even wrote a book on demonology, attacking the more sensible and reasonable views of Scot and Wier. It must be remembered, however, that, in these times, the generality of learned and able men believed in the maleficent effects of sorcery and

the black art. The bench of bishops and the bench of judges alike took part in what seems to us a hideous and wanton brutality. Even so great a writer as Sir Thomas Browne, who tells us, "for the sorrows of others he has quick sympathy," gave evidence against two unhappy women charged before Sir Matthew Hale at Bury St. Edmunds, and his evidence helped to secure their iniquitous conviction.

Browne, like many of his day, was a firm believer in horoscopes—"I was born in the planetary hour of Saturn and I think I have a piece of that leaden planet in me." He was, however, perhaps a little in advance of some of his contemporaries; at any rate, he recognised that foretellings based on star-gazing do not always "make good." "We deny not the influence of the stars but often suspect the due application thereof." During the civil war, both sides used astrologers and acted on their prognostications; but, on the whole, the firm belief that future events could be foretold by a study of the planetary system was waning. "They" (*i.e.* the stars) "incline but do not compel . . . and so gently incline that a wise man

may resist them; *sapiens dominabitur astris*: they rule but God rules them.”<sup>4</sup> This was said by Robert Burton, and it probably represents the average opinion of the more educated in our period.

The part played by alchemy in the life of the times can be judged by Ben Jonson's *Alchemist*, first acted in 1610, which affords a true insight into the fashionable craze of the time. The play was constantly presented from that date until the closing of the theatres and, on the restoration, was one of the first plays to be revived. Jonson certainly had mastered the jargon of this form of quackery, and showed a profound knowledge of the art of its professors. In *Epicoene, or the Silent Woman*, he refers to the love philtres of one Forman, a most flagrant rascal who was mixed up with the Overbury trial.

It has been said that a competent man of science should be able to put into language “understood of the people” any problem, no matter how complex, at which he is working. This seems hardly possible in the twentieth

<sup>4</sup> *Anatomy of Melancholy*, part 1, sec. II, Mem. 1, sec. IV.

century. To explain to a trained histologist double  $\theta$  functions or to a skilled mathematician the intricacies of karyokinesis would take a very long time. The introduction in all the sciences of technical words is due not to any spirit of perverseness on the part of modern *savants*; these terms, long as they usually are, serve as the shorthand of science. In the Stewart times, however, an investigator could explain in simple language to his friends what he was doing, and the advance of natural science was keenly followed by all sorts and conditions of men.

Whatever were the political and moral deficiencies of the Stewart kings, no one of them lacked intelligence in things artistic and scientific. The pictures at Windsor and at Buckingham Palace which the nation owes to Charles I and Charles II are only approached by those it owes to the knowledge and taste of Queen Victoria's consort. At Whitehall, Charles II had his "little elaboratory, under his closet, a pretty place,"<sup>5</sup> and was working there but a day or two before his death, his

<sup>5</sup> Pepys, 16 Jan. 1669.



illness disinclining him for his wonted exercise. The king took a curious interest in anatomy; on 11 May 1663, Pierce, the surgeon, tells Pepys "that the other day Dr. Clerke and he did dissect two bodies, a man and a woman before the King with which the King was highly pleased." Pepys also records, 17 February 1662-3, on the authority of Edward Pickering, another story of a dissection in the royal closet by the king's own hands.

It has, I think, seldom been pointed out that Charles II's ancestry accounts for many of his qualities and especially for his interest in science. He was very unlike his father, but his mother was the daughter of a Medici princess, and the characteristics of that family are strongly marked in the "merry monarch." His gaiety and wit and his skill in money matters when he chose to apply himself, all bring to mind the Italian family from which he sprang. Even the swarthy complexion of Charles II was probably due to his Italian blood, and his fondness for outdoor sports is another trait which is often observed in the Medici themselves. There is an old en-

graving of a portrait of Lorenzo (d. 1648), the brother of Cosimo II, which shows an astonishing resemblance to Charles II; and it is interesting to remember that Cosimo II earned his chief claim to the gratitude of posterity by his courageous encouragement, protection and support of Galileo, who owed to him the opportunity and means of making his famous astronomical discoveries.

Another royal personage, Prince Rupert, "full of spirit and action, full of observation and judgment," about this time invented his "chemical glasses which break all to dust by breaking off a little small end: which is a great mystery to me."<sup>6</sup> He had, says Gramont, *quelques talens* for chemistry and invented a new method for making gunpowder, for making "hails hot" and for boring cannon. His traditional invention of the almost lost art of mezzotint is probably due to the fact that, at an early date, the real inventor, Ludwig von Siegen, explained to him his process and that Prince Rupert demonstrated with his own hands this new method of engraving to Evelyn.

<sup>6</sup> Pepys, 13 Jan. 1662.

Another aristocratic inventor, Edward Somerset, second marquis of Worcester, has received more credit than he deserved. He was interested in mechanics and employed a skilled mechanic, one Kaltoff, in his laboratory, but his claims to have invented a steam-engine do not bear critical investigation, and his well-known *Century of Inventions* does not rise to the level of *The Boy's Own Book* of the last century. Many of his suggestions, though ingenious, are based on fallacies, and comparatively few of them were practical.

A curiously versatile amateur in science was Sir Kenelm Digby. Like most prominent men of his time, he intervened in theological questions, besides playing an active part in public affairs. He was an original member of the Royal Society, but although he is reported to have been the first to record the importance of the "vital air"—we now call it oxygen—to plants, and although he had gifts of observation, his work lay largely in the paths of alchemy and astrology, and he seems to have had recourse to a lively imagination in estimating the results of his experiments. He

trafficked in the transmutation of metals, and his name was long associated with a certain "powder of sympathy" which, like the "absent treatment" of the twentieth century practitioners of Christian Science, "acted at a distance." Evelyn looked on him as a quack, "a teller of strange things," and Lady Fanshawe refers to his infirmity of lying; he was certainly a great talker. Still, other men of his epoch spoke well of him and his conversation was doubtless stimulating if profuse.

In mathematics, John Wallis was, to some extent, a forerunner of Newton. At Felsted School and at Emmanuel College, he received the curiously wide education of his age. He was a skilled linguist; although he had taken holy orders, he was the first of Francis Glisson's pupils to proclaim in public Harvey's discovery on the circulation of the blood, but his bent was towards mathematics, and he possessed an extraordinary memory for figures. His *Arithmetica Infinitorum* is described as "the most stimulating mathematical work so far published in England." It contained the germs of the differential calculus, and it sug-

gested to Newton, who "read it with delight," the binomial theorem. In it  $\pi$  was evaluated, and it must not be forgotten that to Wallis we owe the symbol for infinity,  $\infty$ . Living in troublesome times, under many rulers, he contrived, not without some loss of popularity, to remain on good terms with all. His services were, indeed, indispensable to a succession of governments, for he had a power of deciphering which was almost miraculous. Cromwell, who seems to have had a great respect for his powers, appointed him Savilian Professor of geometry at Oxford in 1649.

Another mathematical ecclesiastic was Seth Ward, bishop of Exeter and afterwards of Salisbury. Ward was educated at Sidney Sussex College and, in 1643, was chosen as mathematical lecturer to the University at Cambridge. But, like Wallis, he was appointed, and in the same year, to a Savilian professorship, that of astronomy—another instance, not uncommon at the time, of men educated at Cambridge but recognised and promoted at Oxford. He took the place of the ejected John Greaves, who magnanimously

used his influence in his successor's favor. Ward was renowned as a preacher; but his later fame rested chiefly on his contributions to the science of astronomy, and he is remembered in the world of science mainly for his theory of planetary motion. Ward and Wallis—but the burden of the attack was borne by the latter—laid bare Hobbes's attempted proof of the squaring of the circle; there was also a little controversy "on the duplication of the cube," and mixed up with these criticisms in the realm of pure reason were political motives. Hobbes had not begun to study Euclid until he was forty; and, after Sir Henry Savile had founded his professorships at Oxford, Wood says that not a few of the foolish gentry "kept back their sons" in order not "to have them smutted by the black art"—so great was the fear and the ignorance of the powers of mathematics. Ward was a pluralist, as was the manner of the times, and Burnet tells us "he was a profound statesman but a very indifferent clergyman." Yet, what money he got he lavishly spent on ecclesiastical and other purposes. As

Bishop of Exeter, he restored, at the cost of £25,000, the cathedral; repaired the palace; considerably increased the value of the poorer benefices of his diocese and of the prebends of his cathedral; and gave a considerable sum of money towards the cost of making the river navigable from his cathedral city to the sea. He founded the Seth Ward almshouses at Salisbury, and he gave certain farms and fee-farm rents for scholarships at Christ's College, Cambridge.

Like the distinguished mathematicians just mentioned, Isaac Newton took a keen interest in certain forms of theology current in his day; but in his intellectual powers he surpassed not only them but all living mathematicians and those who lived after him. His supreme genius has ensured him a place in the very small list of the world's thinkers of the first order. He, too, exercised a certain influence in affairs, and, during his later years, he took a keen interest in theological speculations; but his activities in these fields are completely overshadowed by the far-reaching importance of his great discoveries as a natural philoso-

pher and a mathematician. As the discoverer of the decomposition of white light in the spectrum, he may be regarded as the founder of the modern science of optics. His discovery of the law of gravitation, and his application of it to the explanation of Kepler's laws of planetary motion and of the principal inequalities in the orbital motion of the moon, made him the founder of the science of gravitational astronomy. His discovery of the method of fluxions entitles him to rank with Leibnitz as one of the founders of mathematical analysis. All these great discoveries gave rise to long and sometimes acrimonious controversies among his contemporaries, relating both to the subjects themselves and to priority of discovery. In a letter to Halley referring to one of these disputes, Newton writes:

Philosophy is such an impertinently litigious lady, that a man has as good be engaged in lawsuits, as have to do with her. I found it so formerly, and now I am no sooner come near her again, but she gives me warning.

His chief work, *Principia*, has been described



by Dean Peacock as "the greatest single triumph of the human mind."<sup>7</sup>

The second man of outstanding genius in British science in the seventeenth century was Harvey, who, like Newton, worked in one of the two sciences which, in Stewart times, were, to some extent, ahead of all the others. Harvey, "the little choleric man" as Aubrey calls him, was educated at Cambridge and at Padua and was in his thirty-eighth year when, in his lectures on anatomy, he expounded his new doctrine of the circulation of the blood to the College of Physicians, although his *Exercitatio* on this subject did not appear till 1628. His notes for the lectures are now in the British Museum. He was physician to Charles I; and it is on record how, during the battle of Edgehill, he looked after the young princes as he sat reading a book under a hedge a little removed from the fight.

In the chain of evidence of his convincing demonstration of the circulation of the blood,

<sup>7</sup> Newton held the office of president of the Royal Society for the last twenty-five years of his life, a period exceeded only in the case of one president, Sir Joseph Banks.

one link, only to be supplied by the invention of the compound microscope, was missing. This, the discovery of the capillaries, was due to Malpighi, who was amongst the earliest anatomists to apply the compound microscope to animal tissues. Still, as Dryden has it,

The circling streams once thought but pools of  
blood—

(Whether life's fuel or the body's food),

From dark oblivion Harvey's name shall save.<sup>8</sup>

Harvey was happy in two respects as regards his discovery. It was, in the main and especially in England, recognised as proven in his own lifetime, and, again, no one of credit claimed or asserted the claim of others to priority. In research, all enquirers stand on steps others have built up; but, in this, the most important of single contributions to physiology, the credit is Harvey's and almost Harvey's alone. His other great work, *Exercitationes de Generatione Animalium*, is of secondary importance. It shows marvellous powers of observation and very laborious research; but, although, to a great extent, it led

<sup>8</sup> Epistle to Dr. Charleton.

the way in embryology, it was shortly superseded by works of those who had the compound microscope at their command. Cowley, a man of wide culture, wrote an *Ode on Harvey* in which his achievement was contrasted with a failing common to scientific men of his own time, and, so far as we can see, of all time:

*Harvey* sought for Truth in Truth's own Book  
The Creatures, which by God Himself was writ;  
And wisely thought 'twas fit,  
Not to read Comments only upon it,  
But on th' original it self to look.  
Methinks in Arts great Circle, others stand  
Lock't up together, Hand in Hand,  
Every one leads as he is led,  
The same bare path they tread,  
A Dance like Fairies a Fantastick round,  
But neither change their motion, nor their ground:  
Had *Harvey* to this Road confin'd his wit,  
His noble Circle of the Blood, had been untrodden  
yet.

Harvey's death is recorded in a characteristic seventeenth century sentence, taken from the unpublished pages of Baldwin Harvey's *Bustorum Aliquot Reliquiae*:

Of William Harvey, the most fortunate anatomist, the blood ceased to move on the third day of the Ides of June, in the year 1657, the continuous movement of which in all men, moreover he had most truly asserted. . .

<sup>9</sup>Ἐν τε τροχῷ πάντες καὶ ἐνὶ πᾶσι τροχοί<sup>9</sup>

Among other great physiologists and physicians, Sir Theodore Turquet de Mayerne (godson of Theodore Beza), who settled in London in 1611, has left us *Notes* of the diseases of the great which, to the medically minded, are of the greatest interest. He almost diagnosed enteric, and his observations on the fatal illness of Henry, Prince of Wales, and the memoir he drew up in 1623 on the health of James I, alike leave little to be desired in completeness or in accuracy of detail.

Before bringing to a close these short notices of those who studied and wrote on the human body, whole or diseased, a few lines must be given to John Mayow of Oxford, who followed the law, "especially in the summer time at Bath." Yet, from his contributions to science, one might well suppose that he had

<sup>9</sup>The writer is indebted for this quotation to Dr. Norman Moore's *History of the Study of Medicine in the British Isles*, Oxford, 1908.

devoted his whole time to research in chemistry and physiology. He it was who showed that, in respiration, not the whole air but a part only of the air breathed in takes an active part in respiration, though he called this part "by a different name, he meant what we now call oxygen."<sup>10</sup>

Thomas Sydenham was one of the first physicians who was convinced of the importance of constant and prolonged observation at the bedside of the patient. He passed by all authority but one—"the divine old man Hippocrates," whose medicine rested also on observation. He, first in England, "attempted to arrive at general laws about the prevalence and the course and the treatment of disease from clinical observation." He was essentially a physician occupied in diagnosis, treatment and prognosis. When he was but twenty-five years old, he began to suffer from gout, and his personal experience enabled him to write a classic on this disease, which is even now unsurpassed.

<sup>10</sup> Foster, Sir Michael, *The History of Physiology*, Cambridge, 1901.

Francis Glisson, like Sydenham, was essentially English in his upbringing, and did not owe anything to foreign education. His work on the liver has made "Glisson's capsule" known to every medical student, and he wrote an authoritative book on rickets. He, like Harvey, was educated at Gonville and Caius College, and, in 1636, became Regius Professor of physic at Cambridge, but the greater part of his life he spent at Colchester. We must perforce pass by the fashionable Thomas Willis and his more capable assistant Richard Lower, with Sir George Ent, and others.

The invention of the microscope mentioned above gave a great impetus to the study of the anatomical structure of plants and later of animals; and in relation to this we must not overlook the work of Nehemiah Grew (1641-1712) who, with the Italian Malpighi, may be considered a co-founder of the science of plant-anatomy. He was the son of a clergyman, who, as clergymen were apt to do in those days, got into trouble under the Act of Uniformity.

Nehemiah studied at Pembroke Hall, Cam-

bridge, and afterwards took his Doctor's Degree at Leiden. He published numerous treatises dealing with the anatomy of vegetables, and with the comparative anatomy of trunks, roots, etc., illustrated with admirable and somewhat diagrammatic plates. Although essentially an anatomist he made certain investigations into plant physiology and suggested many more. Perhaps his most interesting contribution to the science, however, was his discovery that flowering plants, like animals, have male and female sexes. It seems odd to reflect that this discovery is only about two hundred and fifty years old. When Grew began to work the study of botany was in a very neglected condition—the old herbal had ceased to interest, and with its contemporary the bestiary, was disappearing from current use, and the work of some of Grew's contemporaries notably Robert Morison and John Ray, hastened their disappearance. Of these two systematists Ray was, on the whole, more successful: Morison's efforts at classifying the vegetable kingdom received much criticism at the time and by no means came up

to the great expectations that he himself had formed of them. Ray's system at any rate obtained in England until the latter half of the eighteenth century, when it was gradually replaced by the Linnaean method of classification.

But Ray has other claims on our regard. He and Francis Willughby, both of Trinity College, Cambridge, attacked a similar problem in the animal kingdom. Willughby was the only son of wealthy and titled parents, whilst Ray was the son of a village blacksmith. But the older Universities are great levellers, and Ray succeeded in infusing his fellow student at Cambridge with his own genuine love for natural history. With Willughby he started out on his methodical investigations of animals and plants in all the accessible parts of the world. Willughby died young and bequeathed a small benefaction and his manuscripts to his older friend. After his death Ray undertook to revise and complete his "Ornithology" and therein paid great attention to the internal anatomy and to the habits and to the eggs of most of the birds he described.



All the innumerable fables which had passed from book to book in the old bestiaries disappeared, for Ray ever showed a healthy scepticism with regard to the marvellous. He, further, edited Willughby's "History of Fishes," but perpetuated the mistake of his predecessors in retaining whales amongst that group. In a rather rationalistic mood he argues that the fish which swallowed Jonah must have been a shark. Perhaps the weakest of the three great histories—the History of Insects—was due to the fact that Ray edited it in his old age.

Ray was always a fine field naturalist, and his catalogues of Cambridgeshire plants long remained a classic. We may perhaps sum up the contributions of this great naturalist in the words of Professor Miall. "During his long and strenuous life he introduced many lasting improvements—fuller descriptions, better definitions, better associations, better sequences. He strove to rest his distinctions upon knowledge of structure, which he personally investigated at every opportunity . . . His greatest single improvement was the divi-

sion of the herbs into Monocotyledons and Dicotyledons . . . He made things much easier for Linnaeus, as did Linnaeus in his turn for naturalists who now smile at his mistakes. Both were capable of proposing haphazard classifications, a fact which need not surprise us, when we reflect how much reason we have to suspect that the best arrangements of birds, teleostean fishes, insects and flowering plants known to our own generation need to be largely recast."

Great as were the seventeenth century philosophers in the biological and medical sciences, they were paralleled if not surpassed by workers on the physical and mathematical side. Robert Boyle—who has been described as the Father of Chemistry and Brother of the Earl of Cork—was, even as a boy of eighteen, one of the leaders in the comparatively new pursuit of experimental science. His first love was chemistry, "Vulcan has so transported and bewitched me as to make me fancy my laboratory a kind of Elysium," thus he wrote in 1649. A few years later (1652-3), in Ireland, where he was called to look after the family

estates, he found it "hard to have any Hermetic thoughts," and occupied his mind with anatomy and confirming Harvey's discovery of the circulation of the blood. A year later, he settled at Oxford, where he arranged a laboratory and had as assistant Robert Hooke. Meetings were held alternately at Boyle's lodgings and at John Wilkins's lodge at Wadham, and were frequented by Seth Ward and Christopher Wren and by many others.

Stimulated by Otto von Guericke's contrivance for exhausting air from a vessel, Boyle, aided by Hooke, invented what was called the "machina Boyliana," which comprised the essentials of the air-pump of today. At this time, Boyle busied himself with the weight, with the pressure and with the elasticity of air—the part it played in respiration and in acoustics. Like Newton, he took a deep interest in theology, and not only spent considerable sums in translating the Bible into foreign tongues, but learnt Greek, Hebrew, Syriac and Chaldee so that he might read it at first hand. He was, indeed, a very notable character. Suffering under continued ill-

health, with weak eyes, a slight stammer, and a memory treacherous to the last degree, he was yet one of the most helpful of friends and universally popular alike at the court of three kings, and in the society of men of letters, men of business and men of science. In spite of the fact that he was the first to distinguish a mixture from a compound, to define an element, to prepare hydrogen though he did not recognise its nature, he had in him the touch of an amateur, but an amateur of genius. His style in writing was unusually prolix and he seldom followed out his discoveries to their ultimate end.

It was men such as these that re-established the Royal Society in 1660. Exactly a century earlier, the first scientific society, the *Accademia Secretorum Naturae* of Naples had its origin. This was followed by several others in Italy and in France, most of them but short-lived. Among English or Teutonic folk, the Royal Society was the earliest to appear, and, even if we include the scientific societies of the world, it has had the most continuous existence. Indeed, before its birth, it underwent a

long period of incubation, and its inception was in reality in 1645. At that date, a society known as the Philosophical, or, as Boyle called it, the "Invisible," College came into being, which met from time to time at Gresham College and elsewhere in London. During the civil war, this society was split in two, some members meeting in London, some at Oxford, but the meetings, wherever held, were at irregular intervals. On the restoration, the meetings were resumed in London and, in 1662, the society received the royal charter.

Of all the poets of the time, Cowley took, perhaps, the greatest interest in science. He had, indeed, like Evelyn and at about the same date, developed a plan for the institution of a college of science. Evelyn explains his scheme in a letter addressed to Robert Boyle, dated 3 September 1659 from Sayes court, which contains minute details as to the buildings, the maintenance, and the government of his college, the inmates of which were to "preserve science and cultivate themselves." Cowley's scheme was also elaborately thought out, and had the original and admirable suggestion

that, out of the twenty salaried professors, sixteen should be always resident and four always travelling in the four quarters of the world, in order that they might "give a constant account of all things that belong to the learning and especially Natural Experimental Philosophy, of those parts." To his "Philosophical Colledge" was to be attached a school of two hundred boys. Both these schemes, according to Bishop Sprat, hastened the foundation of the Royal Society, of which both projectors were original members.

Cowley's poems were greatly admired during his lifetime, later critics have considered him affected, perhaps because, like Donne, he understood, and was not afraid to use, the technical language of the schools. We have quoted some of his lines on Harvey, and may add a few from the ode with which he greeted the birth of the Royal Society:

From . . . . . all long Errors of the way,  
 In which our Praedecessors went,  
 And like th' old *Hebrews* many years did stray  
 In Desarts but of small extent,  
*Bacon*, like *Moses*, led us forth at last

The barren Wilderness he past,  
Did on the very Border stand  
Of the blest promis'd Land,  
And from the Mountains Top of his Exalted Wit,  
Saw it himself, and shewed us it.  
But Life did never to one Man allow  
Time to Discover Worlds, and Conquer too ;  
Nor can so short a Line sufficient be  
To fadome the vast depths of Natures Sea :  
The work he did we ought t' admire  
And were unjust if we should more require  
From his few years, divided 'twixt th' Excess  
Of low Affliction, and high Happiness.  
For who on things remote can fix his sight,  
That's always in a Triumph, or a Fight?

Donne, who, like Cowley, indulged in quaint poetical conceits and who founded a new school of poetry, abjuring classical conventions and classical characters, and treating of topics and objects of everyday life, was not afraid of realism. "Upon common objects," Dr. Johnson tells us, he was "unnecessarily and unpoetically subtle." Time limits us to one quotation:

Marke but this flea, and marke in this,  
How little that which thou deny'st me is ;  
It suck'd me first, and now sucks thee,  
And in this flea, our two bloods mingled bee.

Donne did not of course foresee the appalling part that these insects, by the habits he mentions, play in the spread of such diseases as bubonic plague and many epizootics in animals.

The dramatists of the Stewart period hardly afford us the help we need in estimating the position occupied by science and by men of science in the world of the seventeenth century. The astrologer and the alchemist were then stock characters of the drama of everyday life, just as the company promoter and the multimillionaire are now. "The Gentlemen of Trinity Colledge" presented "before the King's Majesty" a comedy entitled *Albumazar*, which takes its name from the chief character, an astrologer, a very arrant knave, and the type of the false man of science. This play, originally printed in 1615, was soon forgotten, but it was revived in 1668 and met with great success:

Samuel Butler, who was not a Fellow of the Royal Society, for some reason difficult to explain, spent much time in attacking it. He wrote his entertaining satire on the *virtuosi*



entitled *The Elephant in the Moon* in short verse, and was so pleased with it that he wrote it over again in long verse. Though this "Satire upon the Royal Society" remains a fragment, enough of it is extant to show Butler did not appreciate what even in these days is not always appreciated, that the minute investigation of subjects and objects which to the ordinary man seem trivial and vain often lead to discoveries of the profoundest import to mankind.

Ben Jonson, with his *flair* for presenting what zoologists call "type species," showed, as has been seen, in his *Alchemist* an unusual but a thorough, mastery of the half scientific and half quack jargon of the craft, so that this play is a quarry for all interested in the history of chemical and physical studies. To the playwright of the time, the man of science or of pseudo-science was a vague, peevish pedant, much occupied with physiognomies, dreams, and fantastic ideas as to the properties and powers of various substances. But there seems to have been a clear distinction drawn between

a real and a false astrology, as is shown in Dryden's *An Evening's Love* (1668).

The above is but an all too brief record of the founding of modern science by our ancestors, your ancestors and mine, under the Stewarts. Not until our own times, your times and mine, did we see a parallel awakening in the Scientific Spirit.

May I in conclusion say again in the sonorous prose of Queen Elizabeth's age there is now as then "a new unexplored Kingdom of Knowledge within the reach and grasp of man, if he will be humble enough, and patient enough, and truthful enough to occupy it."











